federal register

Wednesday
January 23, 1980

Part IX

Department of Energy

Office of Conservation and Solar Energy

Federal Energy Management and Planning Programs; Methodology and Procedures for Life Cycle Cost Analyses

DEPARTMENT OF ENERGY

Office of Conservation and Solar Energy

10 CFR Part 436

[Docket No. CAS-RM-79-107]

Federal Energy Management and Planning Programs; Methodology and Procedures for Life Cycle Cost Analyses

AGENCY: Department of Energy.

ACTION: Final rule.

SUMMARY: The Department of Energy (DOE) is issuing a final rule to establish a methodology and procedures to conduct life cycle cost analyses, involving estimation and comparison of the cost effects of replacing building systems with energy-saving alternatives in existing Federal buildings, or of selecting among alternative building designs containing different energy-using building systems for a new Federal building. This methodology will be Subpart A of the new Part 436 of Title 10 of the Code of Federal Regulations and will be used in accordance with the guidelines for Federal building plans to reduce consumption of scarce fossil fuels for building energy use and with the rule for solar demonstration project proposals which are Subparts C and D of Part 436, respectively.

EFFECTIVE DATE: January 23, 1980.

FOR FURTHER INFORMATION CONTACT:

William H. Rhodes, Office of Conservation and Solar Energy, Department of Energy, 20 Massachusetts Ave., N.W., Washington, D.C. 20585 (202/376-4720).

Neal J. Strauss, Office of the General Counsel, Department of Energy, 20 Massachusetts Ave., N.W., Washington, D.C. 20585 (202/376-4723).

SUPPLEMENTARY INFORMATION:

A. Introduction

On April 30, 1979, the Department of Energy (DOE) published a proposed rule (44 FR 25366) to establish the methodology and procedures for conducting life cycle cost analyses. The purpose of these analyses is to evaluate and compare the estimated cost effects of investments in existing and new Federal buildings. The purpose of these investments is to substitute renewable or more plentiful non-renewable energy for scarce resources or reduce consumption of non-renewable resources. The proposed methodology would involve a systematic comparison of the estimated cost effects (measured in dollars) of investment decisions, using a discount factor to relate future to present values.

DOE received 17 written comments and eight persons testified at hearings held in San Francisco, California; Kansas City, Missouri; and Washington, D.C.; May 17, June 4 and 19, 1979, respectively. The total of 25 comments were from a broad spectrum of interests representing both the governmental (Federal and state) and the private sectors.

The final rule incorporates a number of changes which reflect DOE's consideration of the comments, as well as information from other sources.

With the issuance of this final rule, DOE amends Chapter II, Title 10 of the Code of Federal Regulations to establish life cycle costing methodology and procedures pursuant to Section 381(a)(2) of the Energy Policy and Conservation Act (EPCA) as amended, 42 U.S.C. 6361(a)(2), Section 10 of the Executive Order 11912, as amended by Executive Order 12003 (Executive Order), and Title V, Part 3, of the National Energy Conservation Policy Act (NECPA), 92 Stat. 3275.

Part 436 comprises the DOE rules for Federal energy management and planning programs under Section 381 of EPCA, the Executive Order, and Title V of NECPA. The subparts which are expected to be included are:

- Subpart A–Methodology and Procedures for Life Cycle Cost Analyses;
- Subpart B–Procedures for Preliminary Energy Audits;
- Subpart C–Guidelines for Buildings Plans;
- Subpart D–Solar in Federal Buildings Demonstration Program Rules;
- Subpart E–Federal Photovoltaic Utilization Program Rules; and
- Subpart F–Guidelines for Energy Management in General Operations of the Federal Government.

The life cycle costing methodology and procedures of Subpart A will be used to evaluate and compare the estimated cost effects of non-renewable energy-saving and renewable energy-saving investments during the formulation and execution of Buildings Plans under Subpart C. Subpart A will also be used to evaluate and compare the estimated cost effects of solar demonstration projects and photovoltaic utilization projects under Subparts D and E. It should be emphasized, however, that the result of a life cycle cost analysis will be treated differently under Subparts C, D and E as provided under law. The result of an analysis will determine investments under the planning guidelines of Subpart C, whereas, under Subparts D and E, it will merely be a factor to be considered in evaluating a proposed solar demonstration project.

Both the Executive Order and Title V of NECPA set requirements for the life cycle costing methodology and procedures promulgated today. Read together, they require that the methodology and procedures be practical, effective, and suitable for estimating:

- Whether retrofitting an alternative building system to an existing Federal building is cost-effective and tends to minimize the life cycle cost of that building;
- Relative cost-effectiveness of retrofit investments in buildings;
- Whether an alternative building design for a new Federal building will minimize the life cycle cost of that building;
- Payback time for solar demonstration projects; and
- Present value of net benefits or excess costs of a solar demonstration project compared to a substitute conventional non-solar alternative building system in an existing Federal building or in the design of a new Federal building.

NECPA requires the Secretary, in consultation with the heads of other agencies, to establish practical and effective methods for estimating and comparing life cycle costs for Federal buildings and to develop and prescribe the procedures to be followed in applying the methods.

Today's rule was developed in consultation with the Office of Management and Budget (OMB), the National Bureau of Standards (NBS), the General Services Administration (GSA), the Department of Defense (DOD), the Veterans Administration (VA) and other Federal agencies, which, among other things, provided information on existing analytical techniques used to estimate life cycle costs. The Director of OMB concurred in the final rule.

Substantial technical assistance was provided by the experts at NBS who are conversant with the technical aspects of life cycle cost analysis and are established consultants in the field. NBS was instrumental in the development of a manual for Federal agencies to use in applying the rule. The manual is entitled "Life Cycle Costing Manual for the Federal Energy Management Program." It will be provided to Federal agencies.

Today's rule will promote standardization of life cycle costing techniques already in use by Federal agencies. This final rule is expected to result in non-renewable energy-conserving and renewable energy

investment decisions which are more consistent and rational among agencies.

B. Summary of Comments on the Proposed Rules and DOE Responses

1. Energy Conservation and Solar Incentives.

The proposed rule requested comments about inclusion of special adjustments to emphasize certain long term social and economic benefits of energy conservation and the use of renewable technologies, such as solar. These benefits are often referred to as "external benefits" because they are not directly reflected (i.e., internalized) in market prices. They are usually difficult to quantify and accrue to society generally. They include avoidance of the negative economic impacts of importing oil on the balance of payments, on domestic employment, and on inflation driven by escalating energy prices. They also include the enhancement of national security by reducing the need to consume relatively insecure fuel supplies, as well as the environmental and health benefits of reduced pollution.

Seven commentors recommended that externality adjustments be included in the methodology. The main points in support of the recommendation were:

- The Federal Government should be the showcase for demonstrating renewable energy technologies and the applications of conservation methods;
- NECPA's purpose is to promote the use of solar heating and cooling in Federal buildings;
- The Federal Government, with a mandate to consider the consequences to the public welfare, must consider the external benefits of various energy options.

In view of the comments, DOE decided to modify the methodology to take account of external benefits by requiring Federal agencies to assume an investment credit of 10 percent of the initial investment cost of both conservation and renewable energy investments as a proxy for externality adjustments. That is to say, each analysis will assume that the initial cost is 90 percent of the actual investment cost. The 10 percent figure was selected after surveying Federal and state tax credits which represent legislative valuations of the external benefit of fossil fuel conserving investments. DOE was especially influenced by the provisions of the Energy Tax Act of 1978 (Public Law 95–618) which distinguished between credits to homeowners and credits to businesses. Because most of the existing building space to be retrofitted and new buildings to be built under this program will be similar to the larger facilities used by businesses, DOE decided to model the investment credit provision of the final rule on the business energy tax credit which is 10 percent of the cost of a conservation or renewable energy investment.

2. Discount Rate.

For the purpose of calculating the present worth of future benefits and costs, the proposed rule provided for the use of a real 10 percent discount rate, that is, a rate not including inflation. This rate was chosen to reflect the opportunity cost of capital in the private sector. It has been in general use since 1972 by Federal agencies for the analysis of most kinds of government investment.

A number of comments were received which suggested a reduced discount rate for conservation and solar investment. Generally, the comments argued that use of the 10 percent rate discriminated against the installation of many conservation measures and alternative energy technologies, such as solar, since their benefits are realized over a long future period while their initial costs are high.

In commenting on the proposed rule, the U.S. Congress Office of Technology Assessment (OTA) examined the behavior of individuals in making their own investment decisions and concluded that the average investor is willing to accept an after-tax return of 0–4 percent in constant dollars allowing for inflation. More importantly, OTA also pointed out that the 0–4 percent figure is close to the discount rate (1.9 percent) used by privately owned electric utilities to make energy-related investment decisions. These discount rates are not directly comparable to the discount rate established in the Office of Management and Budget (OMB) Circular No. A–94, which is a before-tax rate of return.

Executive Order 12003 requires that the life cycle cost methodology shall be consistent with the OMB Circular No. A–94, which establishes a standard discount rate to be used in evaluating time-distributed costs and benefits. A standard discount rate is provided so the many investments considered by various Federal agencies are analyzed using a consistent methodology to the maximum extent possible. The discount rate is selected so Federal investments are made using investment criteria which reflect the opportunity cost of diverting resources from the private sector to the public sector. The current 10 percent discount rate is derived from an estimate of the real before-tax rate of return in the corporate sector of the economy. Circular A–94 is being reviewed. Until that review is complete, no change will be made in the 10 percent discount rate. As part of that review, OMB will consider the appropriateness of the 10 percent discount rate.

3. Energy Price Forecasts

The energy price projections included in the proposed rule were based on average retail prices. Several comments were received pointing out that the average prices were unrealistically low, and that many worthwhile energy conservation and renewable energy projects would be disapproved as the direct result.

DOE has given extensive consideration to alternative concepts of price projections. It has been argued that changes in Federal energy use have an impact at the margin and, therefore, the prices should be based on marginal prices rather than average prices. Marginal prices would approximate the price of fuel that would result if Federal price controls on oil and gas were removed. DOE believes that such marginal prices would more accurately reflect the true value of energy savings to the Nation. In addition to its consideration of marginal cost prices, DOE is considering proposing the further adjustment of prices to reflect the premium value to the nation of saving energy, particularly oil and gas. This adjustment may be proposed as a substitute for the externality adjustment factor required by the rule and discussed above.

While much progress has been made in developing marginal price projections and estimates of the premium value of energy savings above such marginal prices, they were not completed for publication as a proposal for inclusion in this rule. Such projections and estimates will be completed in the near future so they can be published in the **Federal Register** not later than March 31, 1980 as a proposed amendment to this rule. DOE believes that it is important to provide an adequate opportunity to the public to comment on marginal price projections because they will be a significant development in price forecasting.

As an interim measure, pending development of marginal prices by fuel type, the final rule provides for the use of the updated and more realistic average retail price projections and escalation rates contained in Appendix C. Subject to certain exceptions, the rule requires each agency to use the base year 1980 prices given in Appendix C, tables C–1 and C–2. With an exception for liquid gas, these 1980 prices are based on projections from price data

available through the second quarter of 1979. The method for projecting the 1980 prices is described in the DOE Energy Information Administration (EIA) "Short-Term Energy Outlook, October 1979" which is available upon request. The 1980 national average prices thus derived were then converted to regional and sectoral values on the basis of conversion factors developed from 1977 price data set forth in Supplement I to Volume III of EIA's Annual Report to Congress, 1978. These conversion factors represent calculated regional and sectoral proportions.

The 1980 prices for Liquid Gas (LG) were estimated from 1977 reported LG prices and 1985 projected LG prices by assuming that the percentage of the total 1977–1985 growth that occurred in LG prices between 1977 and 1980 was the same as that which occurred in U.S. average Natural Gas (NG) prices for the residential sector. For example, based on the 1977, 1980, and 1985 average U.S prices for residential natural gas of $4.01, $5.80, and $6.45, respectively, it can be calculated that 73.4 percent of the total growth projected to occur during the 1977–85 period occurred between 1977 and 1980. Assuming that, this same percentage of the total growth in LG prices from 1977 to 1985 for the Residential Sector in DOE Region 2 occurred between 1977 and 1980, one can derive 1980 LG prices as follows: multiply the increase in price of $1.88 per MBtu (obtained by finding the difference between the 1985 price of $6.43 and the 1977 price of $4.55) by 73.4 percent to find $1.38, the estimated increase in price between 1977 and 1980. Now, add the $1.38 to the 1977 price to obtain the 1980 estimated price of $5.93.

The exception from the requirement to use the given base year prices permits agencies to use the most recent purchase price in cases where a time of day or demand charge for electricity is involved, or in cases where the actual price is higher.

The prices and escalation rates used in this final rule for years subsequent to 1980, were developed from the December, 1979, results of the Mid-Term Energy Forecasting System (MEFS), developed by DOE's EIA.

MEFS is an integrated computer model of the domestic energy system with explicit representation at the regional level of the supplies of and demand for petroleum products, natural gas and coal; cost of petroleum refining, electricity generation, and transportation; and price sensitivity of energy demands. In forecasting future energy supply, demand and prices, MEFS simulates the effects of a number of different variables, such as economic growth, world oil prices and the discovery of additional domestic energy resources. In order to reflect the uncertainty of such forecasts, EIA developed a range of forecasts based on different assumptions about key variables.

The projected energy prices used in this final rule represent the preliminary results of a forecast based on a series of "pessimistic" assumptions regarding long term world and domestic energy supplies. These "pessimistic" assumptions result in energy price projections on the high end of the range of forecasts developed by EIA. For example, this high price case assumes that the price in 1990 of a barrel of crude oil on the world market (in 1980 dollars) will be $40.78. This is contrasted by a mid-price case which assumes the 1990 world oil price to be $32.98 (in 1980 dollars). For purposes of comparison, the proposed rule was based on a projected 1990 world oil price of $23.50 per barrel (in 1978 dollars).

As can be seen from recent movement in world oil prices, the "high" case more closely reflects actual price trends than does the mid price case. Therefore, DOE has selected the high price case as the most suitable at this time for use in developing estimates and making energy conserving investments in Federal Buildings.

Specific assumptions upon which the high price case is based include:

1. Real (inflation adjusted) annual growth rate for the Gross National Product (GNP) will average 3.9 percent a year from 1980 to 1985 and about 3.3 percent per year thereafter.

2. The world oil price per barrel increases linearly to $34.15 in 1985, to $40.78 in 1990, to $46.22 in 1995.

3. The provisions of the National Energy Act are fully implemented.

4. Domestic oil prices are decontrolled by September 30, 1981.

5. There is no oil pipeline from the West Coast to eastern portions of the U.S.

6. A gas pipeline from Alaska would be in place by 1985.

7. The United States Geological Survey low domestic resource base exists.

8. The utility reserve margin may not exceed 35%. As a result, utilities might retire some oil-fired units before the end of their useful life regardless of oil price.

A more detailed description of the assumptions underlying the price forecasts is contained in an EIA service report entitled, "Modified MEFS Runs Describing Alternative Implementation of the Powerplant and Industrial Fuel Use Act (SR/1A/70–11) Oct., 1979." This document also sets forth the assumptions for scenarios other than the high price case.

4. Computer Applications

A number of comments were made concerning the use of computer programs and models that various agencies and consultants have been using. One commentor stated that the proposed rule does not effectively encourage the use of computer programs for energy and life cycle cost analysis. Another recommended mandatory computer modeling to include life cycle analysis where over a million dollars of building construction is involved. Another commentor suggested that computer models be updated in light of recent price realities.

DOE wishes to stress the following points relating to the use of computer and computer models for life cycle costing analysis:

Computer modeling for major retrofit or new buildings projects is desirable, but is not a mandatory requirement;

The rules do not preclude the use of computer analysis provided the basic cost factors are those contained in the Tables accompanying the rule, and the computer algorithms conform to the procedures and methodology of the rule;

The rule, § 436.14(b), describes the step-by-step calculation procedures to facilitate computer programming; and

A simple computer program has been written in BASIC language to follow the methodology and procedures of the rule. It is provided in the manual entitled "Life Cycle Costing Manual for the Federal Energy Management Program."

5. § 436.11—Definitions

Section 436.11 defined "replacement cost" to mean "future costs to replace a building system or any component thereof which wears out." One comment criticized the definition because it appeared to exclude obsolete systems or components. In response to this comment, DOE deleted the limiting words "which wears out."

Another commentor suggested a narrower definition of "alternative building systems" which would require that the energy savings be a percentage of the overall cost savings. The purpose of the suggestion was to ensure that retrofit projects to be analyzed under this rule are primarily energy conservation projects. DOE carefully considered this suggestion but decided that it would not be desirable since some projects such as fuel switching and energy management systems may not save energy but nonetheless may be beneficial to the Nation's energy activities.

A final suggestion was made to add a definition for energy costs which would include costs associated with kilowatt hour consumption, demand charges, and other special utility provisions such as time-of-day rates. It was stated that without inclusion of these utility cost features, a life cycle cost analysis may ignore important factors in the energy cost of a building. DOE has adopted this suggestion and has made appropriate changes in the final rule.

6. § 436.13—Presuming Cost-Effective Results

Three comments were made concerning § 436.13(b)(2), which states that retrofitting a building is not life cycle cost-effective when occupied under a lease that excludes the cost of utilities. One commentor pointed out that the wording appeared to preclude energy-saving investments in leased buildings when the Government does not pay the utility bills.

The intent of this provision is to specify that the Federal Government should not make energy-saving investments in leased buildings unless there is a provision for a pass-through of savings to the Government.

A comment was made concerning that portion of § 436.13(a) which states that where investment and other costs for retrofitting an existing building are insignificant, then the agency may presume it is life cycle cost-effective without further analysis. The commentor pointed out that there are also situations in the design of a new building where alternative building system costs are insignificant and the benefits substantial.

DOE is in agreement with this comment and has made the necessary change to § 436.13(a) of the rule so as to treat alternative building systems for new building designs the same as retrofits to existing buildings.

Two commentors suggested that DOE include a dollar value threshold for projects below which a life cycle cost analysis as required under this rule would not be necessary. One commentor recommended a threshold of $200,000 while the other recommended a threshold of $1,000,000. The reason given for the suggestion was that it would be too burdensome and uneconomical to perform analysis on projects with low dollar costs.

DOE has not adopted this suggestion. The final rule retains the provision of the proposed rule which allows agencies to presume life cycle cost-effectiveness without analysis when investment and other costs are insignificant. DOE believes the suggested threshold of $1,000,000 or even $200,000 would effectively eliminate life cycle cost analysis as an analytical tool in evaluating most investments, and would be inconsistent with the intent of both the Executive Order and NECPA.

7. § 436.14—Methodological Assumptions

Two comments were received on § 436.14(c) concerning the requirement that the fuel prices given in Appendix C be utilized, or if higher, the actual known costs. The intention was to eliminate the words "if higher" thus allowing agencies to use actual known costs if higher or lower. DOE did not accept the suggestion. Some agencies are able to purchase energy at artificially low prices, e.g., hydroelectric power in the northwest. Using the actual costs in these situations would certainly build in a bias toward energy sources which are not significantly expandable to meet future demand.

Section 436.14(d)(2) imposes a maximum constraint of 30 years on the evaluation period for retrofit projects and new building designs. One commentor urged that the 30-year maximum be strengthened to a 30-year standard time frame for analysis to increase uniformity in the evaluations. Another suggested that a maximum time period should not be imposed because it would "penalize longevity."

Prior to issuance of the final rules, a survey of agency practices revealed that a wide range of periods were being used in calculating the life of a building; some as low as 10 years, others as great as 40 years. Several agencies established a uniform number of years, such as 25 years, to be used for all buildings, while others specified a maximum length for the economic evaluation period.

In formulating the rules for building life, DOE considered the following possibilities: (1) not specifying a life and leaving the choice to agency discretion, (2) setting a common building life to be used by all agencies for all buildings, and (3) setting a maximum time constraint, but giving agencies discretion to designate building life within the confines of the limit imposed. The life cycle costing task force was asked to consider these alternatives. The first possibility, not giving any guideline on building life, was rejected because of the desirability of promoting uniformity and consistency among agencies.

The second, the designation of a simple, uniform life to be used by all agencies, was rejected because it was too narrow to meet the diverse circumstances of the many different agencies. Greater uniformity in approach is sought, but not at the sacrifice of accuracy in the estimation of key variables.

The third possibility, setting flexible study period guidelines with 30 years as a maximum time constraint, was adopted because it offers the following advantages: it recognizes the diversity of buildings and building life and, within limits, leaves it up to the individual agencies to predict the life of their buildings; and it provides a degree of uniformity by preventing the use of building lives in excess of 30 years which would involve extremely unreliable estimates of future cash flows.

There were two comments made with respect to § 436.14(e) which required that the useful life of any major building renewal or overhaul be estimated by the "manufacturer or any other reliable source." The commentors stated that professional engineers or architects might be better qualified under some circumstances to make such estimates. DOE has changed the final rule to read "manufacturer, engineer or architect or other reliable source."

In response to an agency's request that continuous compounding be allowed to accommodate its existing practice, DOE compared alternative compounding procedures under appropriately selected scenarios. The comparisons revealed that the net effect of continuous compounding, starting with the DOE-stipulated annual discount rate and the DOE-stipulated energy price escalation rates, is to increase the present value of energy savings, both by lowering the effective discount rate and by raising the effective price escalation rates. With a low discount rate (like 3 percent) and low price escalation rates, this biasing effect will tend to be quite small, but with a higher discount rate (i.e., 10 percent) and higher price excalation rates (i.e., 8 and 9 percent), the effect could be significant.

Although increases in the present value of future costs—which would also result from continuous compounding—would, to some extent, offset the increases in present value savings, the increases in savings could be expected to be substantially greater than the increases in costs for most projects, thereby tending to raise net present value.

The net effect of continuous compounding would be to give an advantage under the rule to agencies employing it. DOE does not believe that the rule should provide for such an advantage since agencies not using continuous compounding would suffer discrimination in competing for budgetary funds. Moreover, the

additional accuracy in estimates to be gained from continuous compounding is more than offset by the complexity added to the analysis.

8. § 436.16—Establishing Non-Fuel Cost Data

Several persons commented that labor, maintenance, and replacement costs related to construction have increased over the past few years at a faster rate than general price inflation and recommended that price escalation factors be provided for these cost categories, as well as for energy. This issue was investigated but it does not appear that there is a reasonable basis for non-fuel construction cost escalation factors because the behavior of construction prices does not indicate a clear long-run trend of increases higher than the rate of inflation.

9. § 436.17—Establishing Energy Cost Data

One commentor proposed that specific formats for costs be required rather than merely encouraged and that agencies use them in the two-step procedure which uses uniform present worth factors pre-adjusted to reflect energy price escalation. DOE considers it unnecessary to mandate the use of specific formats in developing life cycle costs. Appropriately, the actual development of the data is left to each agency to perform in accordance with its own internal procedures and formats, but each must comply with these DOE-established methods, procedures and assumptions.

To aid those commentors who expressed a desire to utilize computers for their life cycle cost calculations, DOE is providing in § 436.14(b) an optional step-by-step method of calculating present value energy costs.

10. § 436.21—Savings-to-Investment Ratio

Some commentors suggested that in lieu of a savings-to-investment ratio, it would be more appropriate to rank retrofit projects on the basis of Btu's saved per investment dollar. Although it is a common measure of the desirability of some conservation investments, it is not consistent with the requirements of NECPA and the Executive Order. The Btu's saved per dollar invested method gives weight to the annual quantity of energy saved, but does not take into account the relative scarcities of different types of energy. This deficiency could result in an analysis concluding that it would be advisable to switch from coal to oil. Moreover, the Btu per investment dollar measure does not account for non-energy savings over the expected life of the project and the time value of money. In the short run, it will yield the largest Btu energy savings (if based on energy consumption at the source) though not necessarily the largest dollar energy savings. In the long run, it may not even yield the largest Btu savings because of lower program efficiency and smaller dollar savings.

Although the Executive Order specifically requires that highest priority be given to the most cost-effective projects, DOE does approve of the use of energy savings per dollar invested for a further ranking of measures which are equally cost-effective. DOE believes that any greater emphasis on Btu's saved per dollar invested would be inappropriate.

11. § 436.23—Sensitivity Analysis

One person recommended an additional requirement which would compel each agency to conduct a sensitivity analysis with respect to every investment. Assumptions as to the availability of energy supplies or the existence of government policies mandating use of certain forms of energy would vary accordingly. DOE decided not to accept this recommendation because the burden of performing such analyses would be high and the results would be too speculative to be of substantial value in evaluating investments at this time.

11. Miscellaneous

There were a number of comments of a technical or editorial nature which have been considered but not specifically discussed. In some instances, these comments led to minor changes in the provisions of the rule. Similar changes were also made in the case of technical or clerical errors that were discovered by DOE in reviewing the proposed rule.

This rulemaking was determined to be "significant" but not "major" under Executive Order 12044, 43 FR 12661. It was also determined that the promulgation of these rules would not constitute a major Federal action significantly affecting the quality of the human environment under the National Environmental Policy Act, as amended, 42 U.S.C. 4321, *et seq.* Notice of that determination was published in the **Federal Register** on April 30, 1979 (44 FR 25366). As described previously, this will become Subpart A of 10 CFR Part 436. Proposed actions to implement this rule under Part 436 will be reviewed on a specific project-by-project basis to determine the need for further environmental review.

In consideration of the foregoing, the DOE hereby amends Chapter II of Title 10, Code of Federal Regulations, by adding Subpart A to Part 436 as set forth below.

Issued in Washington, D.C., January 15, 1980.

T. E. Stelson,

Assistant Secretary, Conservation and Solar Energy, Department of Energy.

Subpart A—Methodology and Procedures for Life Cycle Cost Analyses

Sec.

436.10 Purpose.
436.11 Definitions.
436.12 Life cycle Cost Methodology.
436.13 Presuming Cost-Effectiveness Results.
436.14 Methodological Assumptions.
436.15 Formatting Cost Data.
436.16 Establishing Non-Fuel Cost Data.
436.17 Establishing Energy Cost Data.
436.18 Measuring Cost-Effectiveness.
436.19 Total Life Cycle Costs.
436.20 Net Savings.
436.21 Savings-to-Investment Ratio.
436.22 Estimated Simple Payback Time.
436.23 Sensitivity Analysis.
436.24–436.29 [Reserved]
Appendix A to Subpart A of Part 436—
Table A–1. Single Present Worth Factors, Based on a 10 percent Discount rate, for finding the present value of future non-fuel, non-recurring costs
Table A–2. Uniform Present Worth Factors, Based on a 10 percent discount rate, for finding the present value of future non-fuel, recurring costs
Appendix B to Subpart A of Part 436
Table B–1 through B–11. Uniform Present Worth Discount Factors Adjusted for Energy Price Escalation for DOE Regions I–X and the United States
Appendix C to Subpart A of Part 436—
Table C–1—Base Year Energy Prices.
Table C–2—Base Year Energy Prices.
Table C–3—Projected 1985 Energy Prices.
Table C–4—Projected 1990 Energy Prices.
Table C–5—Projected 1995 Energy Prices.
Table C–6—Energy Price Escalation Rates 1980–1985.
Table C–7—Energy Price Escalation Rates 1985–1990.
Table C–8—Energy Price Escalation Rates 1990–1995 and Beyond.

Authority: Energy Policy and Conservation Act, as amended, (42 U.S.C. 6361); Executive Order 11912, as amended, 42 FR 37523 (July 20, 1977); National Energy Conservation Policy Act, Title V, Part 3, 92 Stat. 3275; Department of Energy Organization Act, (42 U.S.C. 7254).

Subpart A—Methodology and Procedures for Life Cycle Cost Analyses

§ 436.10 Purpose.

This Subpart establishes a methodology for estimating and comparing the life cycle costs of Federal buildings and for determining life cycle cost-effectiveness. The methodology evaluates the economic consequences of investments in alternatives building

systems for existing Federal buildings and alternative building designs for new Federal buildings under Subpart C of this Part, and in solar hot water, solar heating or solar heating and cooling projects, and photovoltaic utilization projects, for Federal buildings under Subparts D and E of this Part.

§ 436.11 Definitions.

As used in this Subpart—

"Alternative building system" means an energy conservation measure, as defined by this section, including a renewable energy system, for an existing Federal building, or a primarily energy saving building system, including a renewable energy system, for consideration as part of the design for a new Federal building.

"Base Year" means the year in which a life cycle cost analysis is conducted.

"Building"means any structure with a roof and walls designed for storage or human use.

"Building system" means any portion of the structure of the building or of any energy-using system in the building.

"Demand charge" means that portion of the charge for electric service based upon the plant and equipment costs associated with supplying the electricity consumed.

"Energy conservation measure" means an installation or modification of an installation in a building which is primarily intended to reduce energy consumption or allow the use of a renewable energy source, including, but not limited to—

(a) Insulation of the building structure and systems within the building;

(b) Storm windows and doors, multiglazed windows and doors, heat absorbing or heat reflective glazed and coated windows and door systems, additional glazing, reductions in glass area and other window and door system modifications;

(c) Automatic energy control systems;

(d) Equipment required to operate variable steam, hydraulic and ventilating systems adjusted by automatic energy control systems;

(e) Solar space heating or cooling systems, solar electric generating systems, or any combination thereof;

(f) Solar water heating systems;

(g) Furnace or utility plant and distribution system modifications including—

(1) Replacement burners, furnaces, boilers, or any combination thereof, which substantially increases the energy efficiency of the heating system;

(2) Devices for modifying flue openings which will increase the energy efficiency of the heating system;

(3) Electrical or mechanical furnace ignition systems which replace standing gas pilot lights; and

(4) Utility plant system conversion measures including conversion of existing oil- and gas-fired boiler installations to alternative energy sources, including coal;

(h) Caulking and weatherstripping;

(i) Replacement or modification of lighting fixtures which increases the energy efficiency of the lighting system;

(j) Energy recovery systems; and

(k) Cogeneration systems which produce steam or forms of energy such as heat, as well as electricity for use primarily within a building or a complex of buildings.

"Existing Federal building" means a Federal building the construction of which was complete by November 9, 1978, or the design of which cannot feasibly be modified after the effective date of Subpart C of this Part.

"Facility" means any group of closely located buildings, none of which is individually metered for all energy sources and for which the actual rate of use of all energy sources can be determined.

"Federal agency" means an Executive agency under 5 U.S.C. 105 (1970), the United States Postal Service, and each entity specified in 5 U.S.C. 5721(1) (B)–(H) (1970).

"Federal building" means any building, structure or facility which is contructed, renovated, leased or purchased in whole or in part for use by the United States, and which includes a heating system, or cooling system, or both.

"Investment costs" means the initial costs of design, engineering, purchase, and installation exclusive of sunk costs.

"Life Cycle Cost" means the total cost of owning, operating and maintaining a building over its useful life, including its fuel and energy costs, determined on the basis of a systematic evaluation and comparison of alternative building systems; except that in the case of leased buildings, the life cycle cost shall be calculated over the effective remaining term of the lease.

"Liquid gas" means propane, butane, ethane, pentane, or natural gasoline.

"New Federal building" means a Federal building for which construction was not completed prior to November 9, 1978, and the design of which can be feasibly modified after the effective date of Subpart C of this Part.

"Non-recurring costs" means costs that are not uniformly incurred annually over the study period.

"Non-fuel operation and maintenance costs" means material and labor costs for routine upkeep, repair and operation exclusive of energy cost.

"Recurring costs" means costs that are incurred uniformly and annually over the study period.

"Replacement costs" means future costs to replace a building system or any component thereof.

"Retrofit" means installation of an alternative building system in an existing Federal building.

"Salvage value" means the value of any building system removed or replaced during the study period, or remaining at the end of the study period, or recovered through resale at the end of the study period.

"Study period" means the time period covered by a life cycle cost analysis.

"Sunk costs" means costs incurred prior to the year in which the life cycle cost analysis occurs.

"Time-of-day rate" means the charge for service during periods of the day based on the cost of supplying services during various times of the day.

§ 436.12 Life cycle cost methodology.

The life cycle cost methodology for this Part is a systematic analysis of relevant costs, excluding sunk costs, over a study period, relating initial costs to future costs by the technique of discounting future costs to present values.

§ 436.13 Presuming cost-effectiveness results.

(a) If the investment and other costs for an alternative building system considered for retrofit to an existing Federal building or for incorporation into a new building design are insignificant, a Federal agency may presume that such a system is life cycle cost-effective without further analysis.

(b) A Federal agency may presume that an investment in an alternative building system for retrofit to an existing Federal building is not life cycle cost-effective if the Federal building is—

(1) Occupied under a short-term lease without a renewal option or with a renewal option which is not likely to be exercised;

(2) Occupied under a lease which includes the cost of utilities in the rent and does not provide a pass-through of energy savings to the government; or

(3) Scheduled to be demolished or retired from service within three years.

§ 436.14 Methodological assumptions.

Except in determining estimated simple payback time, each Federal agency shall assume:

(a) That the annual discount rate is 10 percent, without inflation, and shall adjust cost data accordingly by applying

the appropriate present worth factors from the tables in Appendices A and B;

(b) That energy prices will rise at rates different from the rate of increase in the general price level, and shall adjust energy cost data accordingly either by a simplified approach whereby the appropriate modified present worth factors based on the 10 percent discount rate and adjusted for energy price escalation for the applicable region, sector, fuel type, and study period from Tables B–1 through B–11 of Appendix B are multilplied by the base-year energy costs, or by a lengthier, step-by-step approach whereby the year-by-year prices of energy are determined by applying the annual compound price growth factors given in Appendix C, Tables C–6, C–7 and C–8 to the price of energy in the preceding year, beginning with the base year price, and then multiplying each year's price by each year's quantity of energy, prior to discounting yearly savings to present value using appropriate single present worth factors given in Table A–1;

(c) That the price of energy in the base year is the price for the appropriate region, sector, and fuel type given in Tables C–1 and C–2 in Appendix C; except that the actual price to the Federal agency of energy delivered to the Federal building shall be assumed when—

(1) That price is highest; or

(2) The alternative building system would affect a component of the price of electricity such as a time of day rate or a demand charge.

(d) That the appropriate study period—

(1) For evaluating or ranking alternative building system retrofits for an owned existing Federal building, is either the lesser of 30 years or the estimated life of the alternative building system or the estimated life of the building;

(2) For determining the total life cycle costs or net savings of mutually-exclusive alternatives for a given building system is an equivalent study period which may be:

(i) The estimated useful life of one of the alternatives with replacement or salvage values estimated for the other alternatives as necessary;

(ii) A common multiple of the useful lives of both alternatives; or

(iii) The lesser of 30 years or the useful life of the building;

(3) For evaluating alternative designs for a new owned Federal building; is the lesser of 30 years or the period of intended use for that building; and

(4) For a leased Federal building, is the lesser of 30 years or effective remaining term of the lease which may include renewal options likely to be exercised;

(e) That the useful life of any building system is the period of service without major renewal or overhaul estimated by a qualified engineer or achitect, as appropriate, or any other reliable source;

(f) That the investment costs are a lump sum occurring at the beginning of the base year and constituting 90 percent of the actual investment costs;

(g) That energy costs and non-fuel operation and maintenance costs begin accruing at the end of the base year; and

(h) That non-investment costs in any year occur in a lump sum at the end of the year in which they are incurred.

§ 436.15 Formatting cost data.

In establishing cost data under § 436.16 and § 436.17 and measuring cost effectiveness by the modes of analysis described by § 436.19–436.22, a format for accomplishing the analysis which includes all the essential elements of the procedure shall be used. Federal agencies are encouraged to use formats such as those set forth in the "Life Cycle Costing Manual for the Federal Energy Management Program."

§ 436.16 Establishing non-fuel cost data.

(a) The revelant non-fuel cost categories are—

(1) Investment costs;

(2) Non-fuel operation and maintenance costs;

(3) Replacement costs; and

(4) Salvage value.

(b) The investment costs are assumed to be a present value under § 436.14(g).

(c) The present value of recurring costs is the product of the base year value of recurring costs as multiplied by the appropriate uniform present worth factor for the applicable study period from Table 2 in Appendix A.

(d) The present value of non-recurring costs under § 436.16(a)(2)–(a)(4) is the product of the non-recurring costs as multiplied by appropriate single present worth factors from Table A–1 of Appendix A for the respective years in which the costs are expected to be incurred.

§ 436.17 Establishing energy cost data.

(a) Each Federal agency shall establish energy costs in the base year by multiplying the total units of energy used in the base year by the price per unit of energy in the base year as determined in accordance with § 436.14(c).

(b) The present value of energy costs over the study period shall be calculated by multiplying the energy costs in the base year as established under § 436.17(a) by the appropriate modified uniform present worth factor adjusted for energy price escalation for the applicable region, sector, fuel type, and study period from Tables B–1 through B–11 of Appendix B; or, by using the step-by-step approach detailed in § 436.14(b).

§ 436.18 Measuring cost-effectiveness.

(a) In accordance with this section, each Federal agency shall measure cost-effectiveness by combining cost data established under § 436.16 and § 436.17 in the appropriate mode of analysis as described in § 436.19–436.22.

(b) Replacement of a building system with an alternative building system by retrofit to an existing Federal building or substitution in the design for a new Federal building shall be deemed cost-effective if—

(1) Total life cycle costs, as described by § 436.19, are estimated to be lower; or

(2) Net savings, as described by § 436.20, are estimated to be positive; or

(3) The savings-to-investment ratio, as described by § 436.21, is estimated to be greater than one.

(c) As a rough measure, each Federal agency may determine estimated simple payback time under § 436.22, which indicates whether a retrofit is likely to be cost-effective under § 436.18(b). An alternative system is likely to be cost-effective if estimated payback time is significantly less than the useful life of that system and of the Federal building in which it is installed.

(d) Mutually exclusive alternatives for a given building system considered in determining such matters as the optimal size of a solar energy system, the optimal thickness of insulation, or the best choice of double-glazing or triple-glazing for windows, shall be compared and evaluated on the basis of total life cycle costs or net savings over equivalent study periods. The alternative which is estimated to result in the lowest total life cycle costs or the highest net savings shall be deemed the most cost-effective because it tends to minimize the life cycle cost of the Federal building.

(e) Cost-effective alternative building systems shall be ranked in descending order of their savings-to-investment ratios.

(f) Alternative building designs for new Federal buildings shall be evaluated on the basis of total life cycle costs. The alternative design which results in the lowest total life cycle costs for a given new building shall be deemed the most cost-effective.

§ 436.19 Total life cycle costs.

Total life cycle costs are the sum of the present values of—

(a) Investment costs less salvage values at the end of the study period;

(b) Non-fuel operation and maintenance costs;

(c) Replacement costs less salvage costs of replaced building systems; and

(d) Energy costs.

§ 436.20 Net savings.

Net savings is the difference in the present values of savings and costs of an alternative building system as compared with the existing building system or with the basic design for a new building. For a retrofit project, net savings may be found by calculating the total life cycle costs for an existing building system and the total life cycle costs for the proposed retrofit system, and then subtracting the total life cycle costs for the proposed system from the total life cycle costs for the existing system. For a new building design, net savings is the difference between the life cycle costs of one alternative compared with the system in the basic design.

§ 436.21 Savings-to-investment ratio.

The savings-to-investment ratio is the ratio of the present value savings of an alternative building system to its increase in present value costs during the study period. The numerator of the ratio is the net difference in present value energy and non-fuel operation and maintenance costs between the proposed alternative and the existing building system or basic design alternative. The denominator of the ratio is the net difference between the proposed alternative and the existing building system or the basic design alternative in present value investment and replacement costs less salvage value.

§ 436.22 Estimated simple payback time.

The estimated simple payback time is the number of years required for the cumulative value of energy cost savings less future non-fuel costs to equal the investment costs of the building system, without consideration of future fuel price increases or discount rates.

§ 436.23 Sensitivity analysis.

If there is uncertainty regarding particular items of cost data, a sensitivity analysis may be performed by varying the analysis under § 436.19–§ 436.21 for those items to determine whether the variation has a significant impact on the result of an analysis.

§§ 436.24–436.29 [Reserved]

Appendix A to Subpart A of Part 436

Table A–1.—*SPW Factors, Based on a 10 Percent Discount Rate, for Finding the Present Value of Future Non-Fuel, Non-Recurring Costs*

Study period	Factor
1	0.91
2	0.83
3	0.75
4	0.68
5	0.62
6	0.57
7	0.50
8	0.47
9	0.42
10	0.39
11	0.35
12	0.32
13	0.29
14	0.26
15	0.24
16	0.22
17	0.20
18	0.18
19	0.16
20	0.15
21	0.14
22	0.12
23	0.11
24	0.10
25	0.09
26	0.08
27	0.08
28	0.07
29	0.06
30	0.06

The formula for finding the present value (P) of a future amount (F) is the following:

$$P = \frac{F}{(1+d)^n}$$

where d = the discount rate, and n = the year in which F occurs.

Table A–2.—*UPW Factors, Based on a 10 Percent Discount Rate, for Finding the Present Value of Future Non-Fuel, Recurring Costs*

Study Period	Factor
1	0.91
2	1.74
3	2.49
4	3.17
5	3.79
6	4.36
7	4.87
8	5.34
9	5.76
10	6.15
11	
12	6.81
13	7.10
14	7.37
15	7.61
16	7.82
17	8.02
18	8.20
19	8.37
20	8.51
21	8.65
22	8.77
23	8.88
24	8.99
25	9.08
26	9.16
27	9.24
28	9.31
29	9.37
30	9.43

The formula for finding the present value (P) of an annually recurring uniform amount (A) is the following:

$$P = A\,\frac{(1+d)^n - 1}{d\,(1+d)^n}$$

where d = the discount rate, and n = the number of compounding periods over which A occurs.

BILLING CODE 6450-01-M

APPENDIX B TO SUBPART A OF PART 436

TABLE B-1 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 1
(MAINE, NEW HAMPSHIRE, VERMONT, MASSACHUSETTS, CONNECTICUT, RHODE ISLAND)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.93	0.87	0.91	0.92	0.93	0.87	0.92	0.98	0.94	0.92	0.92	0.92	0.90
2	1.80	1.62	1.75	1.78	1.80	1.62	1.77	1.94	1.83	1.77	1.77	1.78	1.71
3	2.60	2.28	2.51	2.57	2.61	2.28	2.55	2.89	2.67	2.54	2.55	2.57	2.44
4	3.35	2.85	3.21	3.29	3.36	2.85	3.27	3.82	3.47	3.26	3.27	3.30	3.10
5	4.04	3.34	3.85	3.97	4.07	3.35	3.93	4.72	4.22	3.92	3.93	3.97	3.69
6	4.67	3.80	4.44	4.59	4.70	3.81	4.56	5.58	4.89	4.54	4.55	4.59	4.24
7	5.23	4.23	5.01	5.16	5.26	4.25	5.14	6.39	5.49	5.13	5.12	5.17	4.74
8	5.73	4.64	5.53	5.69	5.77	4.67	5.69	7.15	6.02	5.68	5.65	5.70	5.21
9	6.19	5.02	6.03	6.18	6.23	5.05	6.21	7.87	6.50	6.20	6.13	6.19	5.63
10	6.59	5.37	6.49	6.63	6.64	5.42	6.70	8.54	6.93	6.70	6.59	6.64	6.03
11	6.96	5.70	6.92	7.07	7.01	5.76	7.15	9.17	7.32	7.16	7.02	7.08	6.39
12	7.29	6.00	7.32	7.49	7.34	6.07	7.57	9.75	7.67	7.58	7.42	7.51	6.73
13	7.59	6.28	7.70	7.89	7.65	6.36	7.96	10.30	7.99	7.98	7.80	7.91	7.04
14	7.87	6.54	8.04	8.28	7.92	6.63	8.32	10.81	8.27	8.36	8.16	8.31	7.33
15	8.11	6.78	8.36	8.66	8.17	6.88	8.66	11.28	8.53	8.70	8.49	8.69	7.59
16	8.34	7.01	8.66	9.02	8.39	7.11	8.97	11.72	8.77	9.03	8.81	9.06	7.84
17	8.54	7.21	8.94	9.37	8.60	7.32	9.26	12.13	8.98	9.33	9.11	9.42	8.07
18	8.72	7.40	9.19	9.71	8.78	7.52	9.53	12.51	9.17	9.61	9.39	9.76	8.27
19	8.88	7.58	9.43	10.03	8.95	7.70	9.78	12.87	9.34	9.87	9.66	10.10	8.47
20	9.03	7.74	9.65	10.35	9.10	7.87	10.02	13.20	9.50	10.12	9.91	10.42	8.65
21	9.17	7.89	9.86	10.65	9.23	8.03	10.24	13.51	9.64	10.34	10.14	10.73	8.81
22	9.29	8.03	10.05	10.94	9.36	8.18	10.44	13.80	9.77	10.55	10.37	11.03	8.97
23	9.40	8.16	10.23	11.22	9.47	8.31	10.62	14.07	9.88	10.75	10.57	11.32	9.11
24	9.50	8.27	10.39	11.50	9.57	8.44	10.80	14.32	9.99	10.94	10.77	11.61	9.24
25	9.59	8.38	10.54	11.76	9.66	8.56	10.96	14.55	10.08	11.11	10.96	11.88	9.36
26	9.68	8.48	10.69	12.01	9.75	8.66	11.11	14.77	10.17	11.27	11.13	12.14	9.47
27	9.75	8.58	10.82	12.25	9.82	8.76	11.25	14.97	10.25	11.42	11.30	12.40	9.57
28	9.82	8.67	10.94	12.49	9.89	8.86	11.38	15.16	10.32	11.56	11.45	12.64	9.67
29	9.88	8.75	11.05	12.72	9.95	8.94	11.50	15.33	10.38	11.69	11.60	12.88	9.76
30	9.93	8.82	11.16	12.94	10.01	9.02	11.61	15.49	10.44	11.81	11.74	13.11	9.84

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-2 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 2
(NEW YORK, NEW JERSEY, PUERTO RICO, VIRGIN ISLANDS)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.90	0.89	0.92	0.93	0.90	0.89	0.93	0.98	0.92	0.97	0.91	0.93	0.94
2	1.70	1.69	1.77	1.78	1.72	1.68	1.78	1.98	1.77	1.92	1.74	1.78	1.82
3	2.42	2.40	2.56	2.57	2.46	2.39	2.58	2.97	2.55	2.84	2.49	2.57	2.65
4	3.07	3.04	3.28	3.30	3.13	3.01	3.31	3.94	3.26	3.74	3.17	3.30	3.43
5	3.65	3.61	3.94	3.98	3.73	3.57	3.99	4.92	3.92	4.61	3.80	3.98	4.16
6	4.19	4.14	4.57	4.61	4.28	4.10	4.63	5.83	4.54	5.43	4.38	4.61	4.83
7	4.68	4.65	5.15	5.18	4.80	4.60	5.23	6.70	5.11	6.21	4.93	5.18	5.45
8	5.13	5.12	5.70	5.72	5.27	5.07	5.79	7.51	5.64	6.95	5.45	5.72	6.03
9	5.55	5.57	6.22	6.21	5.70	5.52	6.32	8.27	6.13	7.64	5.93	6.21	6.55
10	5.94	5.99	6.71	6.66	6.10	5.94	6.82	8.99	6.59	8.30	6.39	6.66	7.04
11	6.29	6.38	7.15	7.10	6.46	6.33	7.28	9.66	7.00	8.91	6.81	7.10	7.49
12	6.60	6.74	7.57	7.52	6.79	6.70	7.71	10.28	7.36	9.48	7.20	7.53	7.91
13	6.89	7.08	7.96	7.93	7.08	7.04	8.11	10.86	7.69	10.01	7.57	7.94	8.30
14	7.14	7.39	8.32	8.32	7.35	7.36	8.48	11.41	7.99	10.51	7.91	8.33	8.66
15	7.37	7.68	8.65	8.69	7.59	7.65	8.82	11.91	8.26	10.97	8.22	8.72	8.99
16	7.58	7.95	8.96	9.06	7.80	7.92	9.14	12.38	8.50	11.40	8.52	9.09	9.30
17	7.77	8.20	9.25	9.41	8.00	8.18	9.44	12.81	8.71	11.80	8.79	9.44	9.59
18	7.94	8.43	9.52	9.74	8.17	8.41	9.71	13.22	8.91	12.17	9.04	9.79	9.86
19	8.09	8.64	9.77	10.07	8.33	8.63	9.97	13.60	9.08	12.52	9.28	10.12	10.10
20	8.23	8.84	10.00	10.38	8.48	8.84	10.21	13.95	9.24	12.85	9.50	10.44	10.33
21	8.35	9.02	10.21	10.69	8.60	9.03	10.43	14.28	9.37	13.15	9.70	10.75	10.54
22	8.46	9.19	10.41	10.98	8.72	9.20	10.63	14.59	9.50	13.43	9.89	11.05	10.74
23	8.56	9.35	10.59	11.26	8.83	9.37	10.82	14.87	9.61	13.69	10.07	11.34	10.92
24	8.66	9.50	10.76	11.53	8.92	9.52	11.00	15.14	9.71	13.94	10.23	11.62	11.09
25	8.74	9.63	10.92	11.79	9.01	9.66	11.17	15.38	9.81	14.17	10.38	11.90	11.24
26	8.81	9.76	11.07	12.04	9.08	9.79	11.32	15.61	9.89	14.38	10.52	12.16	11.39
27	8.88	9.87	11.20	12.28	9.15	9.92	11.46	15.83	9.96	14.58	10.66	12.41	11.52
28	8.94	9.98	11.33	12.51	9.21	10.03	11.59	16.03	10.03	14.76	10.78	12.65	11.64
29	8.99	10.08	11.45	12.74	9.27	10.14	11.72	16.21	10.09	14.94	10.89	12.89	11.76
30	9.04	10.18	11.56	12.95	9.32	10.23	11.83	16.38	10.14	15.10	11.00	13.12	11.87

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-3 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 3
(PENNSYLVANIA, MARYLAND, WEST VIRGINIA, VIRGINIA, DISTRICT OF COLUMBIA, DELAWARE)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.91	0.90	0.93	0.93	0.90	0.89	0.93	1.01	0.92	0.93	0.91	0.93	0.94
2	1.73	1.72	1.79	1.79	1.72	1.68	1.79	2.02	1.78	1.80	1.75	1.79	1.84
3	2.47	2.45	2.58	2.59	2.45	2.39	2.58	3.04	2.57	2.60	2.52	2.58	2.68
4	3.15	3.11	3.32	3.33	3.12	3.02	3.32	4.07	3.30	3.35	3.22	3.32	3.47
5	3.76	3.71	4.01	4.02	3.72	3.58	4.00	5.10	3.97	4.05	3.86	4.00	4.22
6	4.32	4.27	4.65	4.66	4.27	4.11	4.65	6.07	4.58	4.73	4.46	4.63	4.92
7	4.82	4.80	5.26	5.24	4.76	4.61	5.25	6.98	5.14	5.39	5.02	5.22	5.56
8	5.28	5.30	5.82	5.78	5.21	5.08	5.82	7.84	5.64	6.04	5.55	5.75	6.15
9	5.70	5.77	6.35	6.28	5.62	5.53	6.35	8.65	6.10	6.67	6.05	6.25	6.70
10	6.08	6.21	6.85	6.74	5.99	5.95	6.85	9.41	6.52	7.29	6.51	6.71	7.21
11	6.42	6.62	7.31	7.18	6.33	6.34	7.32	10.11	6.90	7.88	6.95	7.15	7.68
12	6.74	6.99	7.74	7.60	6.64	6.70	7.75	10.77	7.24	8.44	7.35	7.58	8.12
13	7.02	7.34	8.14	8.01	6.92	7.04	8.15	11.38	7.56	8.98	7.72	7.99	8.52
14	7.29	7.67	8.51	8.40	7.18	7.36	8.52	11.94	7.85	9.50	8.07	8.38	8.90
15	7.53	7.96	8.85	8.78	7.41	7.64	8.87	12.47	8.12	10.00	8.39	8.76	9.25
16	7.74	8.24	9.16	9.14	7.63	7.91	9.19	12.96	8.36	10.47	8.69	9.13	9.57
17	7.94	8.50	9.46	9.49	7.82	8.16	9.49	13.42	8.58	10.92	8.97	9.49	9.88
18	8.13	8.74	9.73	9.83	8.00	8.39	9.77	13.84	8.78	11.36	9.23	9.83	10.16
19	8.29	8.96	9.99	10.15	8.17	8.60	10.03	14.23	8.97	11.77	9.47	10.16	10.41
20	8.44	9.16	10.22	10.46	8.31	8.80	10.27	14.60	9.14	12.17	9.69	10.48	10.66
21	8.58	9.35	10.44	10.76	8.45	8.99	10.49	14.94	9.29	12.55	9.90	10.78	10.88
22	8.71	9.52	10.64	11.04	8.57	9.16	10.70	15.26	9.43	12.91	10.09	11.08	11.09
23	8.82	9.68	10.83	11.32	8.69	9.32	10.89	15.55	9.56	13.26	10.27	11.37	11.28
24	8.93	9.83	11.00	11.59	8.79	9.46	11.07	15.82	9.68	13.59	10.44	11.64	11.46
25	9.03	9.97	11.16	11.84	8.89	9.60	11.23	16.08	9.79	13.91	10.59	11.91	11.62
26	9.11	10.10	11.31	12.09	8.97	9.73	11.39	16.32	9.89	14.22	10.74	12.16	11.78
27	9.19	10.22	11.45	12.32	9.05	9.84	11.53	16.54	9.98	14.51	10.87	12.41	11.92
28	9.27	10.33	11.58	12.55	9.12	9.95	11.66	16.74	10.06	14.79	10.99	12.65	12.05
29	9.33	10.43	11.70	12.77	9.19	10.05	11.78	16.93	10.13	15.05	11.11	12.88	12.17
30	9.39	10.52	11.81	12.97	9.25	10.15	11.90	17.11	10.20	15.31	11.21	13.10	12.29

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For $i = 1$ to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-4 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 4
(KENTUCKY, TENNESSEE, NORTH CAROLINA, SOUTH CAROLINA, MISSISSIPPI, ALABAMA, GEORGIA, FLORIDA, CANAL ZONE)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.91	0.92	0.94	0.93	0.92	0.91	0.93	1.01	0.94	1.00	0.92	0.93	0.96
2	1.75	1.76	1.81	1.80	1.76	1.74	1.81	2.04	1.82	1.99	1.77	1.80	1.89
3	2.50	2.53	2.63	2.60	2.53	2.49	2.62	3.08	2.64	2.99	2.54	2.60	2.78
4	3.20	3.24	3.39	3.35	3.23	3.18	3.38	4.13	3.42	3.98	3.26	3.35	3.64
5	3.83	3.89	4.11	4.05	3.88	3.81	4.10	5.19	4.14	4.97	3.92	4.05	4.46
6	4.41	4.49	4.78	4.70	4.47	4.39	4.76	6.20	4.81	5.96	4.54	4.69	5.23
7	4.94	5.04	5.41	5.29	5.01	4.93	5.39	7.14	5.42	6.95	5.12	5.29	5.94
8	5.43	5.55	6.00	5.84	5.51	5.43	5.98	8.04	5.98	7.93	5.66	5.84	6.59
9	5.87	6.03	6.55	6.35	5.96	5.89	6.54	8.88	6.49	8.90	6.18	6.35	7.20
10	6.28	6.47	7.07	6.82	6.38	6.32	7.06	9.67	6.97	9.88	6.66	6.82	7.76
11	6.65	6.88	7.55	7.27	6.76	6.72	7.55	10.41	7.40	10.79	7.10	7.27	8.28
12	6.99	7.26	8.00	7.70	7.11	7.10	8.00	11.10	7.80	11.64	7.52	7.71	8.76
13	7.30	7.62	8.41	8.11	7.42	7.45	8.41	11.74	8.16	12.43	7.90	8.13	9.20
14	7.59	7.95	8.80	8.51	7.72	7.78	8.80	12.34	8.50	13.17	8.26	8.53	9.61
15	7.85	8.26	9.16	8.90	7.98	8.09	9.16	12.89	8.80	13.86	8.60	8.92	9.99
16	8.09	8.55	9.49	9.27	8.23	8.38	9.50	13.41	9.09	14.51	8.91	9.30	10.34
17	8.31	8.81	9.79	9.62	8.45	8.65	9.81	13.89	9.34	15.11	9.19	9.66	10.66
18	8.51	9.06	10.08	9.96	8.65	8.90	10.10	14.34	9.58	15.67	9.46	10.01	10.95
19	8.69	9.30	10.34	10.29	8.84	9.14	10.37	14.76	9.80	16.20	9.71	10.35	11.23
20	8.86	9.52	10.59	10.60	9.01	9.36	10.62	15.15	10.00	16.69	9.94	10.67	11.48
21	9.01	9.72	10.82	10.90	9.17	9.57	10.85	15.51	10.18	17.15	10.15	10.98	11.71
22	9.16	9.91	11.03	11.19	9.31	9.76	11.07	15.85	10.35	17.58	10.35	11.28	11.93
23	9.28	10.09	11.22	11.47	9.44	9.94	11.27	16.16	10.50	17.98	10.54	11.57	12.13
24	9.40	10.25	11.40	11.74	9.56	10.11	11.46	16.45	10.64	18.35	10.71	11.85	12.31
25	9.51	10.40	11.57	12.00	9.67	10.27	11.63	16.72	10.77	18.70	10.87	12.12	12.48
26	9.61	10.55	11.73	12.24	9.77	10.42	11.79	16.98	10.89	19.03	11.02	12.38	12.64
27	9.70	10.68	11.88	12.48	9.86	10.56	11.94	17.21	11.00	19.33	11.15	12.63	12.78
28	9.78	10.80	12.01	12.71	9.94	10.69	12.08	17.43	11.09	19.61	11.28	12.87	12.91
29	9.86	10.92	12.13	12.93	10.02	10.81	12.21	17.64	11.19	19.88	11.40	13.10	13.04
30	9.93	11.03	12.25	13.14	10.09	10.93	12.33	17.83	11.27	20.13	11.51	13.33	13.15

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$.

TABLE B-5 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 5
(MINNESOTA, WISCONSIN, MICHIGAN, ILLINOIS, INDIANA, OHIO)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.91	0.93	0.92	0.93	0.91	0.93	0.93	0.95	0.93	0.96	0.91	0.93	0.91
2	1.73	1.79	1.77	1.79	1.75	1.79	1.78	1.85	1.80	1.89	1.74	1.79	1.75
3	2.48	2.59	2.55	2.59	2.52	2.59	2.57	2.71	2.60	2.79	2.49	2.59	2.51
4	3.16	3.33	3.28	3.33	3.22	3.34	3.31	3.53	3.35	3.65	3.18	3.33	3.21
5	3.78	4.02	3.94	4.02	3.86	4.03	3.98	4.30	4.05	4.48	3.80	4.02	3.85
6	4.35	4.66	4.57	4.66	4.44	4.67	4.62	5.03	4.69	5.30	4.39	4.66	4.44
7	4.86	5.25	5.16	5.24	4.97	5.26	5.22	5.72	5.27	6.11	4.94	5.26	4.99
8	5.34	5.79	5.71	5.79	5.46	5.80	5.79	6.37	5.81	6.90	5.46	5.81	5.49
9	5.77	6.29	6.23	6.30	5.91	6.30	6.32	6.96	6.30	7.67	5.95	6.32	5.96
10	6.16	6.75	6.72	6.77	6.31	6.77	6.82	7.56	6.74	8.44	6.41	6.79	6.39
11	6.52	7.17	7.17	7.22	6.68	7.20	7.29	8.10	7.15	9.14	6.84	7.24	6.79
12	6.84	7.57	7.60	7.66	7.02	7.60	7.72	8.60	7.53	9.79	7.24	7.68	7.16
13	7.14	7.94	7.99	8.08	7.33	7.98	8.13	9.07	7.87	10.39	7.61	8.11	7.51
14	7.42	8.29	8.35	8.48	7.62	8.33	8.50	9.51	8.18	10.95	7.95	8.52	7.83
15	7.67	8.61	8.69	8.87	7.87	8.66	8.85	9.91	8.47	11.46	8.27	8.92	8.12
16	7.90	8.92	9.01	9.25	8.11	8.97	9.17	10.29	8.74	11.93	8.57	9.30	8.39
17	8.11	9.20	9.30	9.62	8.33	9.26	9.47	10.64	8.98	12.37	8.84	9.67	8.65
18	8.30	9.46	9.57	9.97	8.53	9.52	9.75	10.97	9.20	12.77	9.10	10.03	8.88
19	8.47	9.70	9.83	10.30	8.71	9.77	10.01	11.28	9.40	13.15	9.34	10.38	9.10
20	8.63	9.93	10.06	10.63	8.87	10.01	10.26	11.56	9.58	13.49	9.56	10.71	9.30
21	8.78	10.14	10.28	10.94	9.02	10.23	10.48	11.83	9.75	13.81	9.77	11.04	9.49
22	8.91	10.34	10.48	11.25	9.16	10.43	10.69	12.08	9.91	14.10	9.96	11.35	9.66
23	9.03	10.52	10.67	11.54	9.29	10.62	10.89	12.31	10.05	14.37	10.14	11.65	9.82
24	9.14	10.69	10.85	11.82	9.40	10.80	11.07	12.52	10.18	14.62	10.31	11.94	9.97
25	9.24	10.85	11.01	12.09	9.51	10.96	11.24	12.72	10.30	14.85	10.46	12.22	10.10
26	9.34	11.00	11.16	12.36	9.60	11.12	11.39	12.91	10.41	15.06	10.61	12.50	10.23
27	9.42	11.14	11.30	12.61	9.69	11.26	11.54	13.09	10.51	15.26	10.74	12.76	10.35
28	9.50	11.27	11.43	12.85	9.77	11.40	11.67	13.25	10.60	15.44	10.87	13.01	10.46
29	9.57	11.39	11.56	13.09	9.84	11.52	11.80	13.40	10.68	15.61	10.98	13.26	10.56
30	9.64	11.50	11.67	13.31	9.91	11.64	11.92	13.54	10.76	15.76	11.09	13.49	10.65

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-8 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 6
(TEXAS, NEW MEXICO, OKLAHOMA, ARKANSAS, LOUISIANA)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.95	0.93	0.94	0.93	0.96	0.96	0.94	1.02	0.99	1.02	0.93	0.93	0.93
2	1.85	1.81	1.83	1.80	1.88	1.88	1.84	2.06	1.97	2.05	1.79	1.80	1.79
3	2.71	2.62	2.67	2.60	2.76	2.76	2.68	3.12	2.94	3.10	2.59	2.60	2.59
4	3.53	3.38	3.46	3.35	3.60	3.61	3.47	4.21	3.90	4.17	3.33	3.35	3.33
5	4.31	4.09	4.21	4.05	4.41	4.42	4.22	5.32	4.86	5.26	4.01	4.05	4.02
6	5.02	4.76	4.91	4.69	5.15	5.19	4.93	6.36	5.73	6.29	4.66	4.70	4.65
7	5.67	5.39	5.57	5.29	5.83	5.91	5.59	7.34	6.54	7.27	5.27	5.30	5.24
8	6.27	5.98	6.19	5.84	6.45	6.60	6.21	8.27	7.28	8.19	5.84	5.85	5.78
9	6.82	6.54	6.77	6.35	7.03	7.25	6.80	9.14	7.97	9.07	6.38	6.37	6.28
10	7.32	7.07	7.31	6.83	7.55	7.87	7.35	9.96	8.59	9.90	6.88	6.84	6.74
11	7.78	7.55	7.82	7.29	8.03	8.44	7.87	10.73	9.17	10.68	7.35	7.31	7.16
12	8.20	8.01	8.29	7.73	8.47	8.97	8.34	11.44	9.69	11.40	7.79	7.75	7.55
13	8.58	8.43	8.73	8.15	8.87	9.47	8.78	12.11	10.16	12.08	8.19	8.18	7.91
14	8.93	8.82	9.13	8.56	9.23	9.94	9.20	12.73	10.60	12.71	8.57	8.60	8.24
15	9.24	9.18	9.51	8.96	9.56	10.37	9.58	13.31	10.99	13.30	8.92	9.00	8.54
16	9.53	9.52	9.86	9.34	9.86	10.77	9.94	13.84	11.35	13.85	9.25	9.39	8.82
17	9.79	9.83	10.18	9.71	10.13	11.14	10.27	14.34	11.68	14.36	9.55	9.76	9.08
18	10.03	10.13	10.48	10.06	10.38	11.49	10.57	14.81	11.98	14.84	9.83	10.12	9.31
19	10.26	10.40	10.76	10.41	10.61	11.82	10.86	15.24	12.25	15.29	10.09	10.47	9.53
20	10.44	10.65	11.02	10.74	10.82	12.12	11.12	15.65	12.50	15.70	10.34	10.81	9.73
21	10.62	10.88	11.27	11.06	11.00	12.41	11.37	16.02	12.72	16.09	10.56	11.14	9.92
22	10.79	11.10	11.49	11.36	11.17	12.67	11.60	16.37	12.93	16.46	10.77	11.45	10.08
23	10.94	11.31	11.70	11.66	11.33	12.91	11.81	16.70	13.11	16.80	10.97	11.76	10.24
24	11.07	11.49	11.89	11.94	11.47	13.14	12.01	17.00	13.28	17.12	11.15	12.05	10.38
25	11.20	11.67	12.07	12.21	11.60	13.36	12.20	17.28	13.44	17.41	11.32	12.33	10.52
26	11.31	11.83	12.24	12.48	11.72	13.55	12.37	17.55	13.58	17.69	11.48	12.61	10.64
27	11.41	11.98	12.39	12.74	11.83	13.74	12.53	17.79	13.71	17.95	11.62	12.87	10.75
28	11.50	12.12	12.54	12.98	11.92	13.91	12.67	18.02	13.83	18.19	11.76	13.13	10.85
29	11.59	12.25	12.67	13.22	12.01	14.07	12.81	18.24	13.93	18.41	11.88	13.38	10.94
30	11.67	12.37	12.80	13.45	12.09	14.22	12.94	18.43	14.03	18.62	12.00	13.61	11.03

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-7 — UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 7
(KANSAS, MISSOURI, IOWA, NEBRASKA)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.90	0.93	0.92	0.93	0.91	0.94	0.93	1.01	0.91	1.02	0.91	0.93	0.91
2	1.71	1.79	1.77	1.79	1.73	1.83	1.79	2.02	1.75	2.05	1.74	1.79	1.74
3	2.43	2.59	2.56	2.59	2.48	2.67	2.59	3.04	2.52	3.10	2.49	2.59	2.49
4	3.09	3.33	3.28	3.33	3.16	3.46	3.33	4.07	3.22	4.16	3.18	3.34	3.18
5	3.68	4.02	3.94	4.02	3.78	4.20	4.01	5.10	3.86	5.24	3.80	4.03	3.80
6	4.21	4.67	4.57	4.66	4.34	4.91	4.66	6.08	4.44	6.31	4.39	4.67	4.38
7	4.69	5.29	5.16	5.25	4.85	5.59	5.27	6.99	4.97	7.37	4.94	5.26	4.92
8	5.13	5.88	5.71	5.80	5.31	6.24	5.84	7.86	5.45	8.41	5.46	5.81	5.42
9	5.53	6.44	6.24	6.31	5.73	6.85	6.38	8.67	5.88	9.45	5.95	6.32	5.88
10	5.90	6.97	6.72	6.77	6.11	7.44	6.89	9.44	6.28	10.47	6.41	6.79	6.31
11	6.22	7.46	7.18	7.23	6.45	7.99	7.36	10.16	6.63	11.46	6.84	7.25	6.70
12	6.52	7.91	7.60	7.67	6.77	8.50	7.80	10.82	6.96	12.40	7.24	7.69	7.07
13	6.79	8.34	8.00	8.09	7.05	8.97	8.21	11.44	7.24	13.31	7.61	8.12	7.40
14	7.03	8.73	8.36	8.50	7.30	9.40	8.59	12.02	7.51	14.18	7.95	8.53	7.71
15	7.25	9.09	8.70	8.89	7.53	9.81	8.94	12.56	7.74	15.01	8.27	8.93	8.00
16	7.45	9.42	9.02	9.27	7.74	10.19	9.27	13.06	7.96	15.81	8.57	9.32	8.27
17	7.63	9.74	9.31	9.64	7.92	10.54	9.58	13.53	8.15	16.58	8.85	9.69	8.51
18	7.79	10.03	9.58	10.00	8.09	10.87	9.86	13.96	8.32	17.32	9.11	10.05	8.74
19	7.93	10.29	9.84	10.34	8.24	11.17	10.13	14.37	8.47	18.03	9.35	10.40	8.96
20	8.06	10.54	10.07	10.67	8.38	11.45	10.37	14.74	8.61	18.71	9.57	10.74	9.15
21	8.18	10.77	10.29	10.99	8.51	11.71	10.60	15.09	8.74	19.37	9.78	11.06	9.32
22	8.29	10.99	10.50	11.30	8.62	11.96	10.82	15.42	8.86	20.00	9.97	11.38	9.49
23	8.39	11.18	10.69	11.60	8.72	12.18	11.02	15.72	8.96	20.60	10.15	11.68	9.64
24	8.48	11.37	10.86	11.89	8.81	12.39	11.20	16.01	9.05	21.18	10.32	11.96	9.78
25	8.56	11.54	11.03	12.16	8.90	12.59	11.37	16.27	9.13	21.73	10.48	12.26	9.92
26	8.63	11.69	11.18	12.43	8.97	12.77	11.53	16.52	9.21	22.27	10.62	12.54	10.04
27	8.69	11.84	11.32	12.69	9.04	12.94	11.68	16.74	9.28	22.78	10.76	12.81	10.15
28	8.75	11.98	11.45	12.94	9.10	13.09	11.82	16.96	9.34	23.27	10.88	13.06	10.25
29	8.80	12.10	11.57	13.18	9.15	13.24	11.95	17.15	9.39	23.74	11.00	13.31	10.35
30	8.85	12.22	11.69	13.42	9.20	13.37	12.07	17.34	9.44	24.20	11.11	13.55	10.43

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-8 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 8
(MONTANA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING, UTAH, COLORADO)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.92	0.99	0.92	0.93	0.93	1.01	0.93	0.99	0.96	1.04	0.92	0.93	0.90
2	1.78	1.98	1.78	1.79	1.81	2.04	1.80	1.98	1.89	2.11	1.76	1.79	1.71
3	2.57	2.96	2.57	2.58	2.62	3.08	2.61	2.95	2.78	3.23	2.54	2.59	2.43
4	3.29	3.94	3.30	3.32	3.38	4.13	3.37	3.92	3.63	4.38	3.25	3.33	3.08
5	3.97	4.91	3.98	4.00	4.09	5.20	4.08	4.88	4.45	5.58	3.90	4.01	3.67
6	4.57	5.80	4.62	4.64	4.73	6.19	4.74	5.78	5.19	6.70	4.52	4.65	4.21
7	5.12	6.64	5.21	5.23	5.30	7.11	5.37	6.64	5.85	7.74	5.09	5.24	4.69
8	5.61	7.41	5.78	5.77	5.82	7.96	5.96	7.44	6.43	8.71	5.64	5.79	5.14
9	6.05	8.13	6.31	6.27	6.28	8.76	6.51	8.21	6.96	9.61	6.15	6.30	5.55
10	6.45	8.80	6.80	6.74	6.70	9.50	7.03	8.92	7.42	10.46	6.63	6.76	5.92
11	6.81	9.41	7.26	7.19	7.08	10.18	7.52	9.59	7.85	11.24	7.08	7.22	6.27
12	7.14	9.98	7.69	7.62	7.42	10.81	7.97	10.22	8.24	11.96	7.50	7.66	6.59
13	7.44	10.51	8.09	8.03	7.74	11.39	8.39	10.80	8.60	12.63	7.89	8.08	6.88
14	7.71	10.99	8.46	8.44	8.03	11.93	8.78	11.34	8.93	13.25	8.25	8.49	7.15
15	7.96	11.43	8.81	8.82	8.29	12.42	9.14	11.85	9.23	13.82	8.58	8.88	7.39
16	8.19	11.84	9.13	9.19	8.53	12.88	9.48	12.32	9.50	14.35	8.89	9.26	7.62
17	8.40	12.22	9.42	9.55	8.75	13.30	9.80	12.76	9.76	14.84	9.18	9.63	7.83
18	8.59	12.57	9.70	9.90	8.95	13.69	10.09	13.16	9.99	15.29	9.45	9.98	8.02
19	8.77	12.89	9.96	10.23	9.14	14.05	10.36	13.55	10.20	15.71	9.70	10.32	8.20
20	8.93	13.19	10.20	10.56	9.30	14.38	10.61	13.90	10.39	16.10	9.94	10.65	8.37
21	9.07	13.46	10.42	10.86	9.46	14.68	10.85	14.23	10.56	16.45	10.15	10.97	8.52
22	9.20	13.71	10.62	11.15	9.60	14.97	11.06	14.54	10.72	16.78	10.35	11.28	8.66
23	9.32	13.95	10.81	11.44	9.72	15.23	11.27	14.83	10.87	17.09	10.54	11.57	8.79
24	9.43	14.16	10.99	11.72	9.84	15.47	11.46	15.09	11.01	17.38	10.72	11.86	8.90
25	9.53	14.36	11.16	11.98	9.95	15.69	11.63	15.34	11.13	17.64	10.88	12.13	9.01
26	9.63	14.54	11.31	12.24	10.04	15.89	11.80	15.57	11.24	17.88	11.03	12.40	9.11
27	9.71	14.71	11.45	12.48	10.13	16.08	11.95	15.79	11.35	18.11	11.17	12.66	9.21
28	9.79	14.86	11.59	12.72	10.21	16.26	12.09	15.99	11.44	18.31	11.30	12.91	9.29
29	9.86	15.01	11.71	12.95	10.29	16.42	12.22	16.18	11.53	18.50	11.42	13.15	9.37
30	9.92	15.14	11.82	13.17	10.35	16.56	12.34	16.36	11.61	18.68	11.53	13.38	9.44

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1} \left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1} \sum_{j=1}^{n_2} \left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2} \sum_{j=1}^{n_3} \left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2} \cdots \left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}} \left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n} \left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1 - \left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-9 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 9
(CALIFORNIA, NEVADA, ARIZONA, HAWAII, TRUST TERRITORY OF THE PACIFIC ISLANDS, AMERICAN SAMOA, GUAM)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.93	1.00	0.91	0.92	0.93	0.97	0.92	1.02	0.94	0.99	0.90	0.93	1.03
2	1.81	2.01	1.74	1.78	1.78	1.91	1.76	2.07	1.82	1.97	1.71	1.78	2.08
3	2.63	3.01	2.50	2.57	2.58	2.82	2.53	3.15	2.65	2.93	2.45	2.58	3.15
4	3.39	4.02	3.19	3.29	3.31	3.71	3.24	4.25	3.43	3.89	3.11	3.32	4.26
5	4.10	5.03	3.82	3.97	3.99	4.56	3.88	5.38	4.16	4.83	3.71	4.00	5.39
6	4.75	5.96	4.41	4.59	4.61	5.35	4.50	6.44	4.81	5.73	4.27	4.63	6.43
7	5.33	6.81	4.97	5.16	5.16	6.07	5.07	7.45	5.41	6.58	4.80	5.21	7.39
8	5.85	7.59	5.49	5.69	5.66	6.74	5.61	8.39	5.94	7.38	5.29	5.75	8.27
9	6.33	8.31	5.98	6.19	6.11	7.35	6.12	9.29	6.42	8.14	5.76	6.25	9.07
10	6.75	8.97	6.44	6.64	6.51	7.91	6.60	10.13	6.85	8.86	6.21	6.72	9.81
11	7.14	9.57	6.87	7.08	6.88	8.42	7.05	10.92	7.24	9.53	6.62	7.17	10.49
12	7.49	10.10	7.27	7.51	7.21	8.88	7.47	11.66	7.59	10.16	7.00	7.61	11.12
13	7.80	10.59	7.64	7.93	7.51	9.29	7.86	12.34	7.91	10.74	7.36	8.03	11.69
14	8.08	11.03	7.99	8.33	7.78	9.67	8.22	12.98	8.19	11.29	7.69	8.45	12.21
15	8.34	11.43	8.31	8.72	8.02	10.01	8.55	13.58	8.45	11.80	8.00	8.85	12.69
16	8.57	11.79	8.61	9.10	8.24	10.31	8.87	14.13	8.68	12.28	8.28	9.24	13.13
17	8.78	12.12	8.89	9.47	8.43	10.59	9.16	14.65	8.88	12.72	8.55	9.63	13.53
18	8.97	12.41	9.14	9.82	8.61	10.84	9.43	15.14	9.07	13.14	8.80	10.00	13.90
19	9.14	12.68	9.38	10.17	8.77	11.07	9.68	15.59	9.24	13.53	9.03	10.36	14.24
20	9.29	12.92	9.61	10.51	8.91	11.27	9.91	16.01	9.39	13.89	9.25	10.71	14.55
21	9.43	13.14	9.81	10.83	9.04	11.46	10.13	16.40	9.53	14.23	9.45	11.05	14.84
22	9.55	13.34	10.01	11.15	9.16	11.63	10.33	16.77	9.65	14.54	9.63	11.39	15.10
23	9.67	13.52	10.19	11.46	9.27	11.78	10.52	17.11	9.76	14.84	9.81	11.71	15.34
24	9.77	13.68	10.35	11.76	9.36	11.91	10.70	17.43	9.86	15.11	9.97	12.03	15.56
25	9.86	13.83	10.51	12.05	9.45	12.04	10.86	17.72	9.95	15.37	10.12	12.33	15.76
26	9.94	13.96	10.65	12.33	9.53	12.15	11.01	18.00	10.03	15.61	10.26	12.63	15.94
27	10.02	14.08	10.79	12.60	9.60	12.25	11.15	18.26	10.11	15.83	10.39	12.92	16.11
28	10.08	14.19	10.91	12.86	9.66	12.34	11.28	18.50	10.17	16.04	10.51	13.20	16.27
29	10.15	14.29	11.03	13.12	9.72	12.43	11.41	18.72	10.23	16.24	10.62	13.48	16.41
30	10.20	14.37	11.14	13.37	9.77	12.50	11.52	18.93	10.28	16.42	10.73	13.75	16.54

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-10 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
DOE REGION 10
(WASHINGTON, OREGON, IDAHO, ALASKA)
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.90	0.96	0.91	0.92	0.91	0.97	0.92	0.96	0.98	1.01	0.91	0.93	0.94
2	1.72	1.89	1.74	1.78	1.75	1.92	1.77	1.89	1.94	2.02	1.73	1.79	1.81
3	2.46	2.79	2.50	2.56	2.52	2.83	2.55	2.79	2.87	3.04	2.47	2.58	2.63
4	3.13	3.65	3.19	3.29	3.22	3.72	3.27	3.65	3.79	4.07	3.14	3.32	3.39
5	3.74	4.49	3.82	3.96	3.86	4.59	3.93	4.48	4.68	5.10	3.75	4.01	4.11
6	4.30	5.25	4.41	4.58	4.45	5.39	4.55	5.27	5.52	6.06	4.32	4.65	4.78
7	4.82	5.96	4.97	5.16	4.99	6.12	5.14	6.01	6.30	6.95	4.86	5.23	5.41
8	5.29	6.60	5.49	5.69	5.49	6.80	5.69	6.71	7.03	7.77	5.37	5.78	5.99
9	5.73	7.20	5.98	6.18	5.95	7.42	6.21	7.38	7.71	8.54	5.85	6.28	6.54
10	6.14	7.75	6.44	6.63	6.38	7.99	6.71	8.00	8.34	9.25	6.30	6.75	7.06
11	6.51	8.24	6.87	7.07	6.77	8.51	7.16	8.59	8.93	9.89	6.72	7.20	7.53
12	6.85	8.70	7.27	7.50	7.13	8.99	7.59	9.14	9.47	10.48	7.11	7.64	7.96
13	7.17	9.11	7.64	7.91	7.46	9.42	7.98	9.64	9.98	11.01	7.47	8.07	8.35
14	7.46	9.49	7.99	8.32	7.77	9.82	8.35	10.12	10.45	11.49	7.81	8.49	8.71
15	7.73	9.84	8.31	8.71	8.06	10.18	8.69	10.56	10.88	11.93	8.13	8.89	9.04
16	7.97	10.15	8.61	9.09	8.31	10.51	9.01	10.98	11.28	12.32	8.42	9.29	9.35
17	8.20	10.44	8.89	9.45	8.54	10.81	9.31	11.36	11.65	12.69	8.69	9.67	9.63
18	8.40	10.70	9.14	9.81	8.76	11.09	9.58	11.72	11.99	13.01	8.95	10.05	9.88
19	8.59	10.94	9.38	10.15	8.96	11.34	9.84	12.06	12.31	13.31	9.18	10.41	10.11
20	8.77	11.16	9.61	10.49	9.14	11.57	10.08	12.37	12.61	13.58	9.40	10.76	10.33
21	8.93	11.36	9.81	10.82	9.31	11.78	10.30	12.67	12.88	13.83	9.61	11.11	10.52
22	9.08	11.54	10.01	11.13	9.46	11.97	10.51	12.94	13.13	14.05	9.80	11.44	10.70
23	9.21	11.71	10.19	11.44	9.61	12.15	10.70	13.19	13.37	14.25	9.97	11.77	10.87
24	9.34	11.86	10.35	11.74	9.74	12.31	10.88	13.43	13.58	14.44	10.14	12.09	11.02
25	9.45	12.00	10.51	12.02	9.86	12.46	11.05	13.65	13.79	14.60	10.29	12.39	11.15
26	9.56	12.12	10.65	12.30	9.97	12.59	11.20	13.86	13.97	14.75	10.43	12.69	11.28
27	9.65	12.24	10.79	12.58	10.07	12.71	11.35	14.05	14.14	14.89	10.57	12.99	11.40
28	9.74	12.34	10.91	12.84	10.16	12.82	11.48	14.23	14.30	15.02	10.69	13.27	11.50
29	9.82	12.44	11.03	13.10	10.25	12.92	11.61	14.40	14.45	15.13	10.80	13.55	11.60
30	9.90	12.53	11.14	13.34	10.33	13.02	11.72	14.56	14.59	15.23	10.91	13.82	11.69

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots\cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

TABLE B-11 – UPW* DISCOUNT FACTORS ADJUSTED FOR ENERGY PRICE ESCALATION[a]
UNITED STATES AVERAGE
STUDY PERIOD 1 IS 1980

	RESIDENTIAL SECTOR				COMMERCIAL SECTOR				INDUSTRIAL SECTOR				
STUDY PERIOD	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	ELECTRICITY	NATURAL GAS	DISTILLATE	RESIDUAL	ELECTRICITY	NATURAL GAS	DISTILLATE	LIQUID GAS	COAL
1	0.92	0.93	0.92	0.93	0.92	0.93	0.93	0.99	0.94	0.99	0.92	0.93	0.94
2	1.75	1.79	1.77	1.79	1.77	1.80	1.79	1.97	1.83	1.98	1.75	1.79	1.82
3	2.52	2.60	2.55	2.59	2.56	2.62	2.59	2.94	2.66	2.96	2.52	2.59	2.65
4	3.23	3.34	3.28	3.34	3.26	3.37	3.33	3.90	3.44	3.94	3.22	3.33	3.43
5	3.87	4.04	3.94	4.03	3.92	4.08	4.01	4.86	4.18	4.91	3.86	4.02	4.16
6	4.46	4.69	4.56	4.67	4.52	4.74	4.66	5.74	4.85	5.85	4.46	4.66	4.83
7	5.00	5.29	5.15	5.26	5.07	5.36	5.27	6.59	5.47	6.75	5.03	5.26	5.46
8	5.48	5.84	5.70	5.80	5.57	5.93	5.84	7.38	6.04	7.61	5.57	5.80	6.04
9	5.93	6.36	6.22	6.31	6.03	6.47	6.38	8.13	6.55	8.45	6.07	6.31	6.57
10	6.34	6.84	6.70	6.78	6.45	6.96	6.88	8.83	7.03	9.25	6.54	6.78	7.07
11	6.71	7.29	7.15	7.23	6.83	7.43	7.35	9.49	7.46	10.01	6.98	7.23	7.53
12	7.04	7.70	7.57	7.66	7.17	7.86	7.78	10.10	7.85	10.71	7.38	7.67	7.95
13	7.35	8.09	7.96	8.08	7.49	8.26	8.19	10.67	8.21	11.36	7.76	8.10	8.34
14	7.63	8.44	8.32	8.48	7.77	8.62	8.57	11.20	8.54	11.97	8.11	8.51	8.69
15	7.88	8.77	8.66	8.87	8.03	8.97	8.92	11.69	8.84	12.56	8.44	8.90	9.02
16	8.11	9.08	8.97	9.25	8.27	9.28	9.24	12.15	9.11	13.08	8.74	9.28	9.33
17	8.32	9.36	9.26	9.61	8.49	9.58	9.54	12.58	9.36	13.58	9.03	9.65	9.61
18	8.52	9.62	9.53	9.96	8.68	9.85	9.83	12.98	9.59	14.05	9.29	10.01	9.87
19	8.69	9.86	9.78	10.29	8.86	10.10	10.09	13.35	9.80	14.48	9.53	10.35	10.11
20	8.85	10.09	10.01	10.61	9.03	10.34	10.33	13.69	9.99	14.89	9.76	10.69	10.33
21	8.99	10.29	10.23	10.93	9.17	10.56	10.56	14.01	10.16	15.27	9.97	11.01	10.53
22	9.12	10.49	10.43	11.23	9.31	10.76	10.76	14.31	10.32	15.62	10.17	11.32	10.72
23	9.24	10.67	10.61	11.52	9.43	10.95	10.96	14.59	10.46	15.96	10.35	11.62	10.89
24	9.35	10.83	10.79	11.80	9.54	11.12	11.14	14.86	10.60	16.26	10.52	11.91	11.05
25	9.45	10.98	10.95	12.06	9.65	11.28	11.31	15.09	10.72	16.55	10.68	12.19	11.19
26	9.54	11.13	11.10	12.32	9.74	11.43	11.47	15.32	10.83	16.82	10.82	12.46	11.33
27	9.62	11.26	11.24	12.57	9.82	11.57	11.61	15.53	10.93	17.07	10.96	12.72	11.45
28	9.70	11.38	11.37	12.81	9.90	11.70	11.75	15.72	11.02	17.31	11.08	12.96	11.57
29	9.76	11.49	11.49	13.05	9.97	11.82	11.87	15.91	11.10	17.53	11.20	13.22	11.67
30	9.83	11.60	11.60	13.27	10.03	11.93	11.99	16.07	11.18	17.73	11.31	13.46	11.77

a. These "modified" uniform present worth discount (UPW*) factors are based on a 10% discount rate and include the EIA projected real escalation rates in energy prices developed from the Mid-Term Energy Forecasting System (MEFS), for the periods 1980–1985, 1985–1990, and 1990–1995 and beyond. The formula for calculating these UPW* factors is the following: For i = 1 to k escalation periods,

$$UPW^* = \sum_{j=1}^{n_1}\left(\frac{1+e_1}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\sum_{j=1}^{n_2}\left(\frac{1+e_2}{1+d}\right)^j + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\sum_{j=1}^{n_3}\left(\frac{1+e_3}{1+d}\right)^j + \cdots\cdots + \left(\frac{1+e_1}{1+d}\right)^{n_1}\left(\frac{1+e_2}{1+d}\right)^{n_2}\cdots\cdots\left(\frac{1+e_{k-1}}{1+d}\right)^{n_{k-1}}\left(\frac{1+e_k}{1+d}\right)^j,$$

where n_i = the length of the period for a given escalation rate in a given period, and the subscript i indicates the escalation period;

d = the discount rate; and $\sum_{j=1}^{n}\left(\frac{1+e}{1+d}\right)^j = \left(\frac{1+e}{d-e}\right)\left(1-\left(\frac{1+e}{1+d}\right)^n\right)$

APPENDIX C TO SUBPART A OF PART 436

TABLE C-1. BASE YEAR ENERGY PRICES
(1980 PRICES PER MILLION BTU IN 1980 DOLLARS)

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	19.14	23.17	16.89	13.16	15.55	13.60	14.80	12.56	16.00	7.03	14.95
Natural Gas (cu. ft.)	7.09	5.81	4.70	3.87	3.87	3.79	3.42	2.97	3.42	5.03	4.12
Distillate (gal.)	6.76	6.57	6.57	6.37	6.24	5.79	6.18	6.18	6.44	6.44	6.50
Liquid Gas (gal.)	5.93	5.99	6.23	6.17	5.72	5.69	5.58	5.90	5.26	5.27	5.80
COMMERCIAL SECTOR											
Electricity (kWh.)	18.60	22.41	16.26	13.33	14.80	12.16	13.33	10.55	15.09	6.89	14.65
Natural Gas (cu. ft.)	6.05	5.12	4.40	3.40	3.51	2.83	2.76	2.54	3.58	4.33	3.58
Distillate (gal.)	6.22	6.16	6.16	5.92	5.92	5.50	5.80	5.68	5.92	5.80	5.98
Residual (gal,)	3.81	3.63	3.63	3.26	4.48	3.15	3.40	3.52	2.89	3.77	3.70
INDUSTRIAL SECTOR											
Electricity (kWh.)	14.07	12.85	11.16	8.54	9.76	8.25	9.86	6.28	12.10	2.63	9.38
Natural Gas (cu. ft.)	4.94	3.71	3.46	2.48	3.06	1.93	2.03	1.96	3.16	3.14	2.51
Distillate (gal.)	6.22	6.70	6.70	6.50	6.44	5.99	6.38	6.18	6.44	6.31	6.44
Liquid Gas (gal.)	5.66	5.70	5.87	5.80	5.51	5.45	5.40	5.64	4.92	4.89	5.53
Coal (ton)	2.96	2.13	1.82	1.84	1.92	2.09	1.75	1.44	1.71	2.05	1.92

TABLE C-2. BASE YEAR ENERGY PRICES[a]
(1980 PRICES PER UNIT OF ENERGY PURCHASED IN 1980 DOLLARS)

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	0.065	0.079	0.058	0.045	0.053	0.046	0.051	0.043	0.055	0.024	0.051
Natural Gas (cu. ft.)	0.007	0.006	0.005	0.004	0.004	0.004	0.004	0.003	0.004	0.005	0.004
Distillate (gal.)	0.938	0.911	0.911	0.883	0.865	0.803	0.857	0.857	0.893	0.893	0.901
Liquid Gas (gal.)	0.566	0.572	0.595	0.589	0.546	0.543	0.533	0.563	0.502	0.503	0.554
COMMERCIAL SECTOR											
Electricity (kWh.)	0.063	0.076	0.055	0.045	0.051	0.042	0.045	0.036	0.052	0.024	0.050
Natural Gas (cu. ft.)	0.006	0.005	0.005	0.004	0.004	0.003	0.003	0.003	0.004	0.004	0.004
Distillate (gal.)	0.863	0.854	0.854	0.821	0.821	0.763	0.804	0.788	0.821	0.804	0.829
Residual (gal.)	0.570	0.543	0.543	0.488	0.571	0.472	0.509	0.527	0.433	0.564	0.554
INDUSTRIAL SECTOR											
Electricity (kWh.)	0.048	0.044	0.038	0.029	0.033	0.028	0.034	0.021	0.041	0.009	0.032
Natural Gas (cu. ft.)	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.003	0.003	0.003
Distillate (gal.)	0.863	0.929	0.929	0.901	0.893	0.831	0.885	0.857	0.893	0.875	0.893
Liquid Gas (gal.)	0.541	0.544	0.561	0.554	0.526	0.520	0.516	0.539	0.470	0.467	0.528
Coal (ton)	72.520	52.185	44.590	45.080	47.040	51.205	42.875	35.280	41.895	50.225	47.040

[a]Note that prices in Tables C-1 and C-2 are equivalent prices stated in different units of energy.
Table C-1 prices are per million Btu (MBtu); Table C-2 prices are per unit of energy typically sold, e.g., kWh of electricity and cubic feet of natural gas.

Prices in Table C-2 were derived from the prices in Table C-1 by multiplying the price per MBtu times the Btu content per sales unit of energy divided by 1 MBtu.

TABLE C-3. PROJECTED 1985 ENERGY PRICES

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	21.45	21.67	16.65	13.40	15.50	17.09	14.01	13.62	18.39	6.87	15.52
Natural Gas (cu. ft.)	5.64	5.32	4.53	4.04	4.30	4.34	3.79	4.63	5.57	6.75	4.61
Distillate (gal.)	6.94	7.04	7.26	7.34	6.69	6.96	6.63	6.74	6.52	6.52	6.96
Liquid Gas (gal.)	6.43	6.54	6.91	6.94	6.34	6.38	6.19	6.50	5.70	5.70	6.45
COMMERCIAL SECTOR											
Electricity (kWh.)	21.05	21.76	15.72	13.88	15.25	15.82	13.25	12.07	16.55	7.10	15.57
Natural Gas (cu. ft.)	4.83	4.60	3.97	3.43	3.91	3.70	3.31	4.36	4.94	6.04	4.08
Distillate (gal.)	6.64	6.74	6.78	6.78	6.47	6.64	6.42	6.45	6.18	6.18	6.62
Residual (gal.)	5.58	5.69	6.04	5.59	5.59	5.61	5.66	5.44	5.25	5.05	5.66
INDUSTRIAL SECTOR											
Electricity (kWh.)	16.96	13.66	12.12	9.98	10.97	12.66	10.18	8.32	14.23	3.79	11.13
Natural Gas (cu. ft.)	5.24	5.21	3.89	3.96	4.10	3.38	3.53	3.78	4.81	5.22	3.92
Distillate (gal.)	6.64	6.71	6.90	6.89	6.47	6.63	6.41	6.50	6.18	6.18	6.65
Liquid Gas (gal.)	6.15	6.22	6.47	6.51	6.12	6.12	6.00	6.24	5.40	5.40	6.15
Coal (ton)	2.82	2.51	2.20	2.45	1.97	2.32	1.76	1.36	3.12	2.36	2.26

Fuel prices per million Btu in 1980 dollars.
Prices based on DOE Mid Range Energy Forecasting System (MEFS) Projection Series "B" (High Case).

TABLE C-4. PROJECTED 1990 ENERGY PRICES

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	20.15	23.20	16.57	13.90	15.84	17.78	13.94	12.92	17.71	7.40	15.77
Natural Gas (cu. ft.)	6.52	6.35	5.37	4.41	4.61	5.15	4.69	5.14	5.84	7.13	5.15
Distillate (gal.)	8.14	8.25	8.47	8.57	7.92	8.18	7.85	7.97	7.72	7.72	8.18
Liquid Gas (gal.)	6.94	7.04	7.41	7.49	6.96	7.01	6.80	7.13	6.21	6.21	7.03
COMMERCIAL SECTOR											
Electricity (kWh.)	19.74	23.30	15.65	14.37	15.59	16.61	13.18	11.37	15.86	7.62	15.84
Natural Gas (cu. ft.)	5.72	5.63	4.81	3.79	4.22	4.52	4.21	4.87	5.21	6.42	4.63
Distillate (gal.)	7.85	7.94	8.00	8.01	7.69	7.87	7.64	7.69	7.39	7.39	7.82
Residual (gal.)	6.67	6.77	7.14	6.71	6.71	6.73	6.77	6.56	6.34	6.13	6.76
INDUSTRIAL SECTOR											
Electricity (kWh.)	15.66	15.21	12.03	10.47	11.32	13.45	10.11	7.62	13.55	4.33	11.51
Natural Gas (cu. ft.)	6.32	6.31	5.53	6.26	6.06	4.16	5.39	4.29	5.90	5.78	5.24
Distillate (gal.)	7.32	7.92	8.11	8.11	7.69	7.85	7.62	7.73	7.39	7.39	7.87
Liquid Gas (gal.)	6.65	6.73	6.97	7.07	6.75	6.75	6.62	6.87	5.91	5.91	6.74
Coal (ton)	3.03	2.69	2.40	2.68	2.15	2.49	1.94	1.39	3.29	2.73	2.47

Fuel prices per million Btu in 1980 dollars.
Prices based on DOE Mid Range Energy Forecasting System (MEFS) Projection Series "B" (High Case).

TABLE C-5. PROJECTED 1995 ENERGY PRICES

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	19.70	22.32	16.90	14.37	16.25	17.93	13.52	13.17	17.09	7.82	15.85
Natural Gas (cu. ft.)	7.10	7.01	5.87	5.00	5.22	5.76	5.18	5.52	5.70	7.26	5.66
Distillate (gal.)	9.05	9.16	9.39	9.49	8.84	9.10	8.77	8.89	8.64	8.64	9.11
Liquid Gas (gal.)	9.33	9.43	9.81	9.88	9.35	9.41	9.20	9.52	8.59	8.59	9.42
COMMERCIAL SECTOR											
Electricity (kWh.)	19.30	22.40	15.97	14.83	16.00	16.75	12.77	11.62	15.25	8.05	15.95
Natural Gas (cu. ft.)	6.30	6.29	5.32	4.39	4.82	5.11	4.69	5.25	5.07	6.56	5.12
Distillate (gal.)	8.76	8.85	8.91	8.94	8.62	8.79	8.57	8.62	8.30	8.30	8.75
Residual (gal.)	7.53	7.64	7.99	7.56	7.60	7.59	7.64	7.42	7.20	6.99	7.62
INDUSTRIAL SECTOR											
Electricity (kWh.)	15.22	14.31	12.36	10.93	11.73	13.59	9.70	7.87	12.93	4.75	11.74
Natural Gas (cu. ft.)	7.16	7.15	7.15	7.16	6.55	4.75	7.08	4.68	6.74	5.74	5.99
Distillate (gal.)	8.76	8.84	9.03	9.04	8.62	8.77	8.56	8.65	8.30	8.30	8.79
Liquid Gas (gal.)	9.04	9.11	9.36	9.46	9.15	9.14	9.01	9.27	8.30	8.30	9.14
Coal (ton)	3.29	2.97	2.66	2.90	2.36	2.65	2.10	1.49	3.43	2.84	2.65

Fuel prices per million Btu in 1980 dollars.
Prices based on DOE Mid Range Energy Forecasting System (MEFS) Projection Series "B" (High Case)

TABLE C-6. ENERGY PRICE ESCALATION RATES 1980-1985[a]
(PERCENTAGE CHANGE COMPOUNDED ANNUALLY)

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	2.31	−1.33	−0.28	0.37	−0.07	4.56	−1.10	1.63	2.83	−0.47	0.75
Natural Gas (cu. ft.)	−4.48	−1.75	−0.75	0.88	2.14	2.74	2.10	9.30	10.24	6.06	2.27
Distillate (gal.)	0.52	1.41	2.01	2.88	1.40	3.76	1.42	1.74	0.26	0.26	1.38
Liquid Gas (gal.)	1.63	1.76	2.11	2.38	2.07	2.32	2.11	1.96	1.61	1.57	2.16
COMMERCIAL SECTOR											
Electricity (kWh.)	2.51	−0.59	−0.67	0.81	0.60	5.40	−0.12	2.73	1.86	0.61	1.22
Natural Gas (cu. ft.)	−4.39	−2.13	−2.03	0.16	2.19	5.51	3.70	11.42	6.66	6.88	2.64
Distillate (gal.)	1.32	1.81	1.95	2.76	1.78	3.85	2.05	2.59	0.87	1.28	2.05
Residual (gal.)	7.93	9.39	10.72	11.39	4.53	12.25	10.74	9.09	12.67	6.01	8.88
INDUSTRIAL SECTOR											
Electricity (kWh.)	3.81	1.24	1.66	3.16	2.36	8.94	0.63	5.79	3.30	7.61	3.49
Natural Gas (cu. ft.)	1.17	7.04	2.36	9.81	6.03	11.86	11.73	14.05	8.77	10.72	9.35
Distillate (gal.)	1.32	0.04	0.60	1.18	0.08	2.05	0.08	1.02	−0.81	−0.41	0.66
Liquid Gas (gal.)	1.66	1.75	1.95	2.35	2.13	2.36	2.15	2.05	1.89	2.01	2.14
Coal (ton)	−0.93	3.30	3.85	5.87	0.56	2.08	0.13	−1.15	12.78	2.89	3.29

[a]Derived from DOE Mid Range Energy Price Forecasts shown in Tables C-1 and C-3.

TABLE C-7. ENERGY PRICE ESCALATION RATES 1985-1990[a]
(PERCENTAGE CHANGE COMPOUNDED ANNUALLY)

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	−1.24	1.38	−0.10	0.73	0.44	0.90	−0.10	−1.05	−0.76	1.50	0.32
Natural Gas (cu. ft.)	2.96	3.60	3.46	1.75	1.39	3.51	4.34	2.10	0.96	1.10	2.25
Distillate (gal.)	3.26	3.21	3.15	3.15	3.43	3.28	3.43	3.41	3.42	3.42	3.28
Liquid Gas (gal.)	1.53	1.51	1.40	1.55	1.90	1.89	1.87	1.86	1.72	1.72	1.73
COMMERCIAL SECTOR											
Electricity (kWh.)	−1.28	1.37	−0.09	0.71	0.45	0.98	−0.11	−1.18	−0.84	1.42	0.35
Natural Gas (cu. ft.)	3.42	4.12	3.91	2.05	1.52	4.06	4.92	2.23	1.08	1.22	2.59
Distillate (gal.)	3.39	3.35	3.36	3.39	3.54	3.45	3.53	3.58	3.63	3.63	3.40
Residual (gal.)	3.63	3.56	3.40	3.73	3.73	3.68	3.65	3.83	3.84	3.98	3.61
INDUSTRIAL SECTOR											
Electricity (kWh.)	−1.58	2.17	−0.14	0.98	0.64	1.22	−0.14	−1.74	−0.98	2.66	0.67
Natural Gas (cu. ft.)	3.85	3.90	7.30	9.61	8.13	4.24	8.81	2.55	4.16	2.04	5.94
Distillate (gal.)	1.95	3.36	3.27	3.31	3.54	3.43	3.54	3.52	3.63	3.63	3.42
Liquid Gas (gal.)	1.60	1.58	1.52	1.65	1.97	1.97	1.97	1.93	1.81	1.81	1.85
Coal (ton)	1.38	1.47	1.76	1.86	1.74	1.49	1.94	0.52	1.04	2.92	1.82

[a]Derived from DOE Mid Range Energy Price Forecasts shown in Tables C-3 and C-4.

TABLE C-8. ENERGY PRICE ESCALATION RATES 1990-1995 AND BEYOND[a]
(PERCENTAGE CHANGE COMPOUNDED ANNUALLY)

DOE Region and Fuel Type	DOE 1	DOE 2	DOE 3	DOE 4	DOE 5	DOE 6	DOE 7	DOE 8	DOE 9	DOE 10	U.S. Average
RESIDENTIAL SECTOR											
Electricity (kWh.)	−0.45	−0.78	0.40	0.67	0.52	0.17	−0.60	0.38	−0.70	1.12	0.10
Natural Gas (cu. ft.)	1.72	2.00	1.83	2.55	2.53	2.24	1.99	1.43	−0.49	0.36	1.90
Distillate (gal.)	2.14	2.11	2.06	2.06	2.23	2.16	2.25	2.21	2.28	2.28	2.19
Liquid Gas (gal.)	6.09	6.01	5.77	5.69	6.07	6.06	6.23	5.95	6.73	6.73	6.02
COMMERCIAL SECTOR											
Electricity (kWh.)	−0.45	−0.78	0.40	0.63	0.53	0.17	−0.64	0.43	−0.79	1.09	0.13
Natural Gas (cu. ft.)	1.95	2.25	2.03	2.94	2.71	2.49	2.20	1.51	−0.55	0.44	2.01
Distillate (gal.)	2.22	2.19	2.18	2.20	2.29	2.24	2.33	2.29	2.35	2.35	2.25
Residual (gal.)	2.46	2.43	2.28	2.42	2.51	2.44	2.43	2.50	2.59	2.63	2.43
INDUSTRIAL SECTOR											
Electricity (kWh.)	−0.56	−1.21	0.54	0.87	0.70	0.21	−0.81	0.64	−0.92	1.89	0.39
Natural Gas (cu. ft.)	2.52	2.53	5.27	2.72	1.55	2.69	5.61	1.76	2.70	−0.12	2.74
Distillate (gal.)	3.66	2.23	2.18	2.20	2.29	2.25	2.34	2.28	2.35	2.35	2.24
Liquid Gas (gal.)	6.32	6.26	6.07	5.99	6.27	6.25	6.35	6.18	7.02	7.02	6.28
Coal (ton)	1.66	1.94	2.08	1.54	1.90	1.20	1.65	1.32	0.85	0.77	1.40

[a]Derived from DOE Mid Range Energy Price Forecasts shown in Tables C-4 and C-5, and assumed to extend up to 15 years beyond 1995.

[FR Doc. 80-2069 Filed 1-22-80; 8:45 am]
BILLING CODE 6450-01-C